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POLGNP: A Detailed Model of Polish GNP

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POLGNP: A Detailed Model of Polish GNP

Summary

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The international financial crisis has increased the need to assess the ability of national economies to grow and prosper in the 1980s even if the key inputs of energy and imports are limited for financial, political, or military reasons. This research paper describes and provides documentation on a new model of the Polish economy, POLGNP, that will allow us to assess Poland's adjustment to resource constraints and the prospects for economic recovery.

POLGNP is a system of mathematical equations which determines the Polish economy's requirements for domestic production, hard currency imports, soft currency imports, and energy in order to achieve particular goals for consumption, investment, defense, civilian government, and exports. Dependence on imports and energy adjusts at different rates and in different directions across economic sectors. Furthermore, energy and import requirements are very sensitive to the mix of production as well as its level. Reliable projections of energy and import needs thus require a high degree of disaggregation. POLGNP starts from given targets for seven domestic end uses of GNP and 12 categories of exports. To achieve those targets, POLGNP balances trade-offs between production in 34 domestic sectors, 12 hard currency import categories, and 12 soft currency import categories. After these have been determined, POLGNP derives requirements for capital, labor, and energy in the forms of coal, oil, gas, and hydro/nuclear.

This paper describes the present version of POLGNP. The second section discusses the structure of the model in general and schematic terms. The third section reviews the performance properties of the model in historical simulation and several alternate future simulations. The fourth section provides an assessment of POLGNP and looks to further development. Three appendixes provide more detailed information on the model, the supporting data development, and historical simulation. Appendix tables also report the result of one simulation over 1982-90 and indicate the degree of detail POLGNP is designed to provide.

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POLGNP: A Detailed Model of Polish GNP

Introduction

Econometric macromodels have been increasingly used to analyze centrally planned economies during the past half decade. They provide a convenient mechanism for examining the interactions of many factors simultaneously and for studying the potential impact of policies and economic events on the path an economy is expected to follow.

Standard macromodels, however, have proved deficient in handling several key issues, which have been particularly important since the late 1970s. Developments in productivity growth; substitutability between domestic and imported inputs; and the changing resource burdens of shifts among—and in the composition of—consumption, investment, defense, and exports have been assumed or roughly approximated. The data and methodology necessary to calculate these relationships have been either unavailable or underutilized, and such microeconomic relationships require a level of detail and sectoral interdependence present in few macromodels.

POLGNP is the product of a continuing effort to develop a model to handle these microeconomic relationships and to relate them to macroeconomic trends in Eastern Europe. POLGNP depends on the fundamental structure of the GNP accounting framework: the demand side of the GNP accounts consists of domestic end uses and exports; the supply side consists of domestic producing sectors and imports. The two sides must always be equal even when the economy is in disequilibrium. The demand components of GNP—consumption, investment, defense, and exports—are fed into the model. They are exogenous variables derived from plan targets or other sources. POLGNP then calculates the supply components of GNP—domestic economic activity in each sector and imports—required to achieve those targets. POLGNP also derives the capital stock, labor input, and energy consumption necessary to support the demand side of GNP.

The primary purpose of POLGNP is to determine the resource costs and, thus, the feasibility of Polish economic recovery, especially the ability of the economy to reduce its dependence on hard currency imports. The structure of the model is designed to accommodate analysis of policy shifts and technological adjustments affecting the trade-offs between domestic production, soft currency imports, and hard currency imports. The model will help to answer the following specific questions:

- What domestic and imported resources will be required to fulfill plans for domestic end uses and exports in the 1980s?
- How successfully is the Polish economy shifting away from dependence on hard currency imports and at what cost?
- Are there particular exports or domestic end uses which can be expanded with a minimal need to increase hard currency imports?

The model has already demonstrated that the technological structure of the Polish economy—under the stress of drastic cutbacks in hard currency imports because of financing problems—shifted abruptly in 1981 away from dependence on hard currency imports.

Figure 1
Conventional Input-Output Analysis

Schematic Input-Output Table

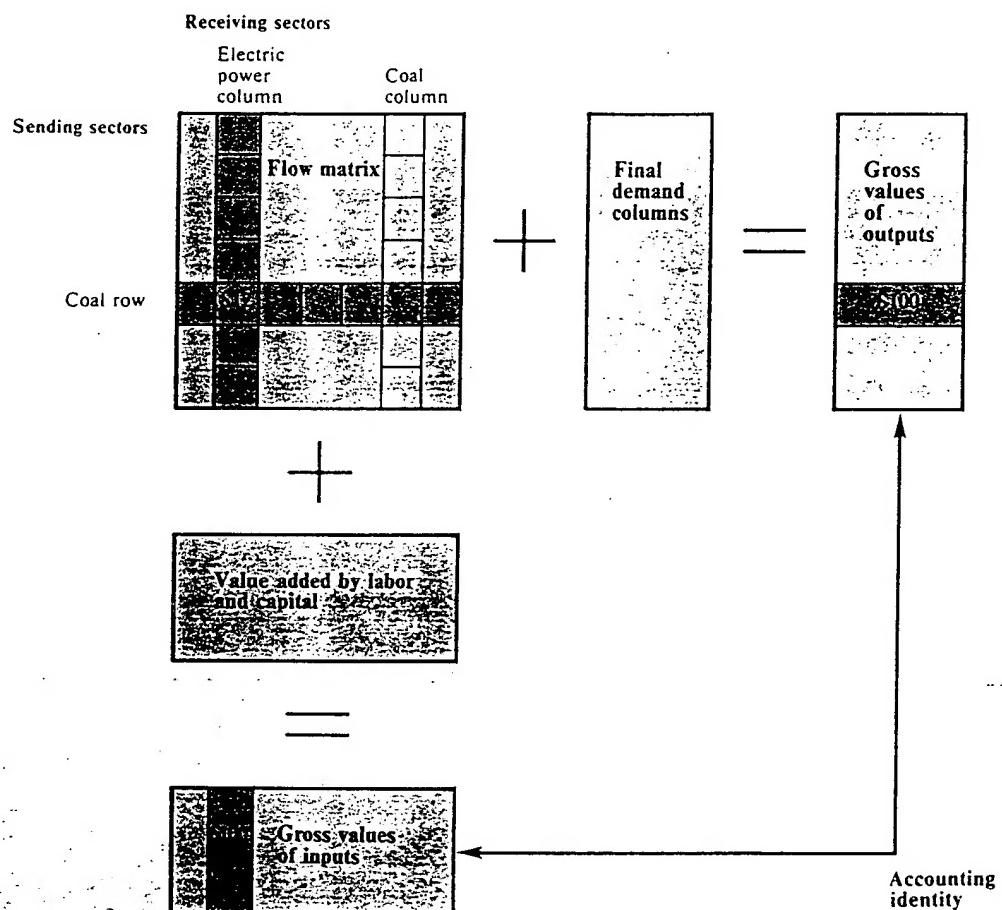


Figure 1, continued

A key element in POLGNP is the 1977 Polish input-output table. The strengths of the input-output table are completeness, consistency, and detail. It includes every transaction that occurred in the economy in the year of the table. The input-output table is a rectangular grid of cells with each sending sector occupying a row of cells and each receiving sector a column of cells. An individual cell then reports total shipments for the year from its row sector to its column sector. For example, the value of coal shipped to electric generating plants is in the single cell in the coal row and electric power column. Each transaction in the economy is included in one cell. The input-output table used for POLGNP has 60 rows and 77 columns for a total of 4,620 cells.

By convention, the right columns in the input-output table are final demand columns—destinations for outputs that are *not* sources of further production. These final demand columns correspond to end uses in GNP accounts—consumption, investment, government spending, additions to inventories, and net exports. These columns (along with some possible extra rows that provide data not used in conventional input-output analysis) are broken off from the input-output table to leave a square matrix (number of rows equals number of columns) consisting only of rows and columns for producing sectors, that is, sectors which provide inputs as well as receive outputs. This matrix is often called the transactions or flow matrix.

Each cell in each column is then divided by the value of total output of the column sector. For example, if the cell in the coal row and electricity column has an entry of \$12 and the total output of the electricity sector is valued at \$100, the quotient in that cell is 0.12; that is, for every dollar of electricity output, the coal sector must deliver 12 cents of coal to the electricity sector. If this division is performed on every entry in the transactions matrix, the result is a matrix of direct-input coefficients.

One limitation of the direct-input coefficient matrix is that it does not represent the total coal requirement for electric power generation but only the direct requirement. The coal sector uses electric power to mine the coal to ship to the electricity sector. Furthermore, the timbers in the coal mines were most likely cut in sawmills run on electricity. To increase electric power output, all the other sectors need more electricity to produce the inputs they must deliver to both the electric power sector and to each other. Every sector in the economy is indirectly dependent in an infinite backward linkage on every other sector in the economy. Wassily Leontief received a Nobel prize for discovering a simple formula to calculate all these linkages and generate a matrix of direct-plus-indirect coefficients, often called a Leontief matrix.

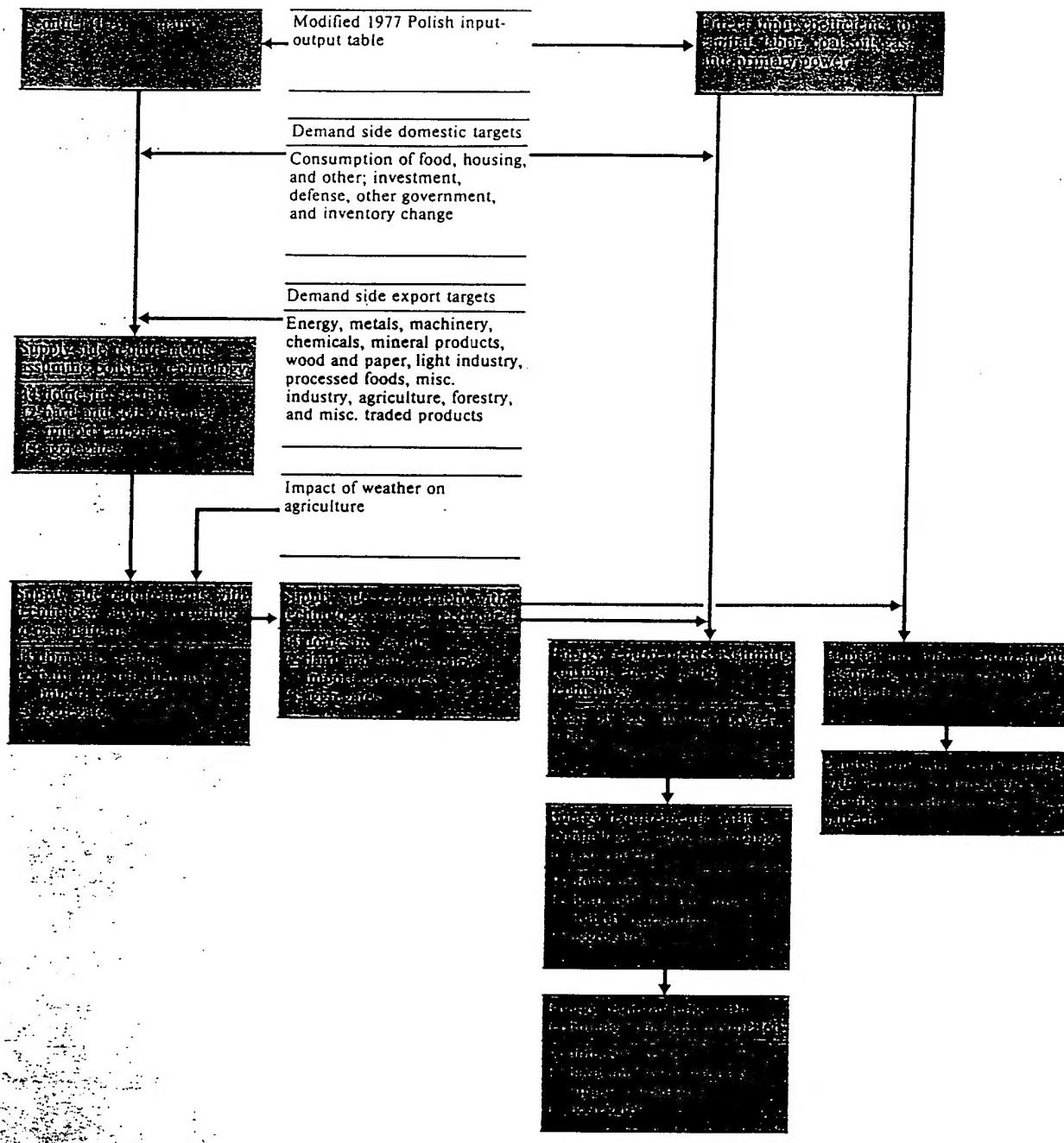
This matrix is a powerful aid in calculating an economy's resource and production needs. For example, by reading down the electricity column of the Leontief matrix, one can determine the additional output required in each sector to add one more unit to the output of the electricity sector. Furthermore, multiplication of each cell in a final demand column such as consumption by its corresponding element in a row of the Leontief matrix (such as electricity) will yield the total direct-plus-indirect electricity requirement to satisfy that level of consumption. This is a typical input-output calculation.

Although quite powerful, conventional input-output analysis must often be modified to deal with particular analytical problems. In POLGNP, these problems include:

- Integration of imports into the full input-output analysis rather than as a column of negative entries under final demand.
- Accounting for changes in the technological relationships reflected in the input-output coefficients, which for POLGNP are constant 1977 coefficients, and projecting those changes into the future.
- Allowing for the probability of unpredicted technological changes in a reasonable way.

Figure 2
General Flow Diagram of POLGNP

Blue tones indicate endogenous variable groups.



An Overview of the Model¹

POLGNP is an annual model consisting of 182 equations connecting a like number of endogenous variables with only 20 exogenous variables. Seventy-eight of the equations are econometric estimates of technological change, 75 reconcile conflicting requirements patterns, 23 are accounting relationships, and six are input-output calculations. Most of the input-output matrix calculations (see figure 1) are performed outside the simulation model because including these calculations in the model would make it too large for the modeling software to handle.

The general structure of the Polish GNP model is shown in figure 2. Since POLGNP is demand driven, the model is devoted to describing the supply response to changes in demand. Each supply response is calculated through three iterations: first, assuming the technology reflected in the 1977 Polish input-output table; second, applying past (1971-81) patterns of technological responses to demand changes individually to each supplying component; and third, allowing for technological change because of factors other than demand changes and reconciling any differences resulting from projecting past patterns of technological change for individual sectors. A smaller portion of the model then estimates the capital, labor, and energy required to support these supply responses using a similar three-step approach.

POLGNP is driven entirely by effective aggregate demand²—domestic end uses³ and exports—and does not respond to other factors (except weather's impact on agriculture). Thus, if a political factor (such as a regime decision to hold down consumption) or an economic factor (such as a shortage of hard currency credits) constrains GNP, this must be reflected in the assumptions about effective aggregate demand that feed into the model. POLGNP calculates the requirements for capital, labor, energy, and imports needed

¹ See appendix A for a more complete technical discussion.

² Effective aggregate demand results in actual expenditure and receipt of goods and services. Aggregate demand may not be effective if goods and services are not available.

³ In GNP accounting, domestic end uses are categories that receive goods and services, but do not supply goods and services within the accounting framework. In POLGNP, these domestic end uses are consumption, investment, government, and additions to inventories.

to satisfy an assumed list of demands; it does not determine whether those requirements can be met. Given a list of available resources, POLGNP cannot tell what domestic end use and export targets policymakers will try to achieve with them. Calculation of the input requirements necessary to sustain a growth target, however, provides a unique capability to assess the feasibility of the target. Moreover, the shares of GNP devoted to consumption, investment, and trade can change dramatically. This framework allows us to examine the implications of changes in the composition as well as the magnitude of GNP.

Model Variables

All projections from a model are conditioned by assumptions regarding the exogenous variables. The exogenous variables in POLGNP fall into three groups.⁴

Demand Side Domestic Targets. These variables include seven end uses of GNP: personal consumption of food, housing, and other goods and services; investment; civilian and military government expenditures; and changes in inventories.

Demand Side Export Targets. These variables include exports divided into 12 commodity categories: energy, metals, machinery and construction, chemicals, mineral products, wood and paper products, light industrial products, processed foods, miscellaneous industrial products, agricultural products, forestry products, and miscellaneous traded goods and services.

Weather. This variable affects the supply response of the sources of agricultural products.

From the three groups of exogenous variables, the model is able to project the endogenous variables.

Aggregate Supply Side Variables. Each of these 13 variables indicates the supply side response from a commodity/service category regardless of source—domestic value added or gross value of imports. The

⁴ All economic variables have been converted into 1977 domestic zlotys unless otherwise noted.

aggregates match the commodity/service groups listed under exports with the addition of a category for nontraded goods and services. [REDACTED]

Domestic Supply Side Variables. Value added is projected for each of 34 producing sectors and then added to obtain GNP. [REDACTED]

Import Supply Side Variables. Imports are projected for each of the 12 commodity/service categories listed and are separated by origin into imports from hard currency and soft currency trading partners, resulting in 24 import categories. [REDACTED]

Energy Requirements. Domestic energy requirements are calculated in barrels per day oil equivalent for coal, oil, gas, and primary electric power (hydro and nuclear). [REDACTED]

Labor and Capital. Labor and capital requirements are calculated in full-time equivalent employees and constant zlotys, respectively. [REDACTED]

Treatment of Issues and Methodological Innovations⁵

POLGNP has been designed specifically to account for the changing substitutability between domestic production, hard currency imports, and soft currency imports. Disaggregation is required since substitutability differs dramatically from sector to sector. For example, there is little physical difference between a barrel of Soviet oil and one imported for hard currency,⁶ but machinery imported for hard currency is often very different technically from domestically produced or CEMA-origin machinery. POLGNP takes these differences in substitutability into account by first treating each of 13 product groups separately. Each group includes value added in one or more domestic production sectors, gross value of hard currency imports, and gross value of soft currency imports. After substitution among the product groups

⁵ Appendix A provides a more complete description of the analytical model. [REDACTED]

⁶ The question of subsidies is not relevant here. Oil imports have been reevaluated in 1977 domestic zlotys regardless of country of origin. Subsidy is a financial issue and does not affect technological substitutability in use. [REDACTED]

[REDACTED] has been treated, POLGNP calculates the effects of substitutions on disaggregated domestic production, hard currency imports, and soft currency imports within each product group. [REDACTED]

POLGNP disaggregates the problems of predicting the supply responses of the Polish economy into component problems for the various product groups and sectors and departs from standard practice in order to handle each of the three component problems as follows:

- The problem of the supply response of each product group and sector to changes in the level and composition of aggregate demand with technology held constant was solved by applying standard input-output techniques to a specially constructed Polish input-output table with a unique treatment of imports.
- The problem of supply response with technological change predicted in response to changes in demand was handled by applying standard econometric regression techniques to equations relating actual sectoral supply responses to the sector supply responses as predicted from the input-output calculations.⁷
- The problem of supply response taking into account both technological change predicted in response to changes in demand and the likelihood of unpredicted technological change was handled by adjusting the sectoral supply responses so that the GNP accounting constraint is obeyed with domestic value added plus imports equal to domestic end uses plus exports. [REDACTED]

Adjustments to reconcile sources and uses of GNP are often made proportionally so that much of the adjustment is imposed on larger sectors. In POLGNP,

⁷ This is quite different from conventional means used to handle technological change in input-output analysis which require projecting changes in all the input-output coefficients. The 58-by-58 transactions matrix underlying POLGNP has 3,364 such coefficients. [REDACTED]

Model Ancestry and Relatives

POLGNP has ancestors in the analytical literature for both centrally planned and Western market economies. The methodology in POLGNP is a continuation and expansion of the Soviet plan feasibility analysis conducted by James Noren and F. Douglas Whitehouse in the 1970s and the input-output-based GNP linkage equation system used in the Brookings Institution model of the US economy. Two useful sources are James H. Noren and F. Douglas Whitehouse, "Soviet Industry in the 1971-75 Plan" in Soviet Economic Prospects for the Seventies, US Congress, Joint Economic Committee, USGPO, 27 June 1973, pp. 206-245; and J. S. Duesenberry, G. Fromm, L. R. Klein, and E. Kuh, editors, The Brookings Quarterly Econometric Model of the United States, Chicago: Rand-McNally Company and Amsterdam: North-Holland Publishing Company, 1965.

POLGNP also has many relatives. The input-output-based linkage in one form or another is central to most macromodels in which supply side sector detail is prominent. Two examples are the Wharton Econometrics and the Data Resources, Inc annual models of the US economy.

POLGNP differs from both its ancestors and relatives in its full integration of imports into domestic economic activity, its treatment of technological changes and their impacts on the economy, and its approach to the issue of hard currency dependence. These unique features make POLGNP a possible paradigm for analyzing other medium- and small-size trade-dependent economies, both market oriented and centrally planned.

POLGNP is also different from SOVMOD, SOVSIM, and other supply-drive models of centrally planned economies. Those models start with available supplies of capital, labor, and energy; allocate those supplies across sectors; and then allocate the products of the sectors to domestic uses and exports. POLGNP starts with exogenous targets for domestic uses and exports and then determines in great detail the domestic production and imports required to meet those targets.

however, this would mean that most of the adjustments to the supply response would occur in domestic as opposed to import sectors only because the domestic sectors are bigger. The adjustments, however, should be proportionate not to sector size but to the relative likelihood of unpredicted technological change affecting the supply responses of the sectors. This variability can be measured by the standard errors¹ of the regressions used to handle the second component problem. This use of the standard errors to adjust proportionately to the likelihood of unpredicted technological change in POLGNP is another departure from common practice. ■

Once the problems of supply response are solved and adjustments are made to reconcile sources and uses of GNP, POLGNP sums the results to yield a detailed picture of the most likely response of the Polish economy to demands placed on it. ■

¹ Standard errors are statistical measures of the degree to which equations err in predicting the values of their dependent variables over historical periods. ■

Simulations of POLGNP

Historical Validation of POLGNP, 1971-81

Validation is the simulation of an equation system over a historical period with comparison of the simulation to history.⁹ POLGNP has been validated over the period 1971-81, twice as long as the period over which POLGNP would normally be simulated and including years of substantial disruption in the Polish economy (see inset, "The Polish Economy, 1970-81").

The results of the validation exercise¹⁰ were very encouraging (see detail in appendix C), but there is as yet no standard against which to compare the results, since, to the best of our knowledge, POLGNP is unique. Rather than serve as a test of success or failure of POLGNP, the validation exercise indicates which sectors in the domestic economy and which import commodity groups are amenable to forecasting and the relative degree of confidence appropriate to those forecasts. Figures 2 and 3 plot the actual and simulated values of key aggregate variables. The

⁹ Although validation is essential in assessing an equation system, it involves potential pitfalls and requires careful assessment. Low errors do not ensure absence of problems, nor do high errors necessarily imply difficulties. Low errors can be achieved by tying a model closely to the circumstances peculiar to the validation period and limiting the flexibility of the model. The model will then track history well but will be unable to forecast well if the economic environment changes. On the other hand, high errors may be expected if the model is validated over a turbulent period as POLGNP has been. Validation assumes knowledge of exogenous variables—in POLGNP, the seven domestic end uses of GNP, the 12 categories of exports, and the severity of weather conditions. (u)

¹⁰ The results are reported for levels rather than average growth rates because average growth rates allow the ups and downs to cancel out. For example, the average annual growth rate of hard currency imports from 1971 to 1981 was 6.3 percent. Over that period, however, the growth in individual years ranged from a high of 48 percent to a low of -31 percent.

following table summarizes the performance of the key aggregates and their components:

	<i>Root mean squared percent- age errors *</i>
Gross national product	1
Average for 34 component sectors	4
Hard currency imports	11
Average for 12 component categories	57
Soft currency imports	9
Average for 12 component categories	20
Capital stock	3
Employment	1
Apparent energy consumption	5
Average for coal, oil, and gas	5

* Method of calculation: (1) calculate the percentage error for each of the 11 years simulated; (2) square the percentage errors; (3) compute the mean or average value of the squared errors; and (4) take the square root of this mean or average. This is the most demanding error statistic because plus-and-minus errors cannot average out over time and large errors receive greater weight.

The relatively high errors for the import categories were examined further. Most of the high errors for imports occurred in 1981 and were concentrated in imports from hard currency trading partners. This suggests an important conclusion—the decline in Poland's hard currency imports in 1981 was much greater than expected, given (1) the drop in GNP, (2) the changing composition of its domestic end uses and exports, and (3) past import dependence. We conclude that the technological structure of the Polish economy—under the stress of drastic cutbacks in hard currency imports because of financing problems—shifted in 1981 abruptly away from dependence on hard currency imports. We do not yet know if this is a

The Polish Economy, 1970-81

POLGNP was validated over a period of turbulent change in the Polish economy. The Polish economy was subjected to several shocks in the 1970s. The decade opened with the workers' revolt in December 1970, which brought Edward Gierek to power. The new regime soon implemented a development strategy based on extensive modernization and growth of the capital stock. The enlarged and improved capital stock was to combine with foreign technology and material inputs to increase productivity and support rising real incomes. By 1973 the Polish economy had developed significant momentum: (1) rapid economic growth was exceeded only by expectations for the future, (2) trade links with the rest of the world expanded dramatically, and (3) energy policy shifted toward the substitution of relatively clean and efficient oil for coal in domestic energy consumption.

The rise of OPEC drastically altered the economic environment. Once cheap and plentiful oil became scarce and expensive. Moreover, Soviet willingness to supply oil below world prices only postponed the need to switch back to coal. Poland's planners also faced recession in the West and stiff competition for export markets from aggressive newly industrializing countries. Polish determination to continue expansionary policies virtually guaranteed that hard currency imports would outrun exports. As the economy became increasingly dependent on imports and failed to improve its export competitiveness, the growing hard currency trade deficit was financed by increased borrowing.

Economic discipline was continually sacrificed to political expediency. Belatedly in July 1980, the regime attempted to impose discipline by sharply raising consumer prices. The move sparked strikes and demonstrations and eventually the formation of Solidarity. In early 1981 Poland suspended payments on servicing its large foreign debt. Serious financing problems required the regime to cut imports drastically. This shock to the economy contributed to a 9-percent decline in GNP during 1979-81.

permanent shift or if it might be due to hard currency imports in the pipeline to final users. ■

The payoff from the sector detail in POLGNP is the minimal size of errors for key aggregate variables. The root mean squared percentage errors for gross domestic product—Poland's reliance on domestic production rather than imports—is only 1 percent.¹¹ The same statistic for total imports is only 3 percent. The mean percentage errors—which allow overestimates and underestimates to cancel—for GNP and imports are zero indicating a very accurate long-run picture of trade-offs in Poland between domestic and imported goods and services. The split in imports between capitalist and socialist sources is less accurate with root mean squared percentage errors of 11 and 9 percent, respectively. Some imports such as oil differ little or not at all between hard currency and soft currency sources. Hence the decision to import from one source or another will depend on availability, price, or even political considerations. Since these factors are not considered in POLGNP, the errors are higher in determining hard and soft currency imports than in determining total imports. ■

Finally, the performance of the equation system in predicting domestic use of energy, capital, and labor is excellent—root mean squared percentage errors of 1 to 5 percent. ■

Baseline Simulation, 1982-90¹²

POLGNP projections depend on assumptions regarding the exogenous variables of the model. These variables define the demands placed on the Polish economy for domestic uses—consumption, investment, government spending, and inventory accumulation—and for exports. In addition, weather conditions affect agriculture, and the rest of the economy must adjust to agricultural performance. Except for weather, these exogenous variables are to some degree

¹¹ Projecting GNP is more difficult the larger the share of foreign trade. The Polish economy meets about four-fifths of the demands placed on it with domestic production rather than imports. (u)

¹² A complete description of the baseline case is provided in appendix D. ■

Figure 3
Historical Validation of POLGNP

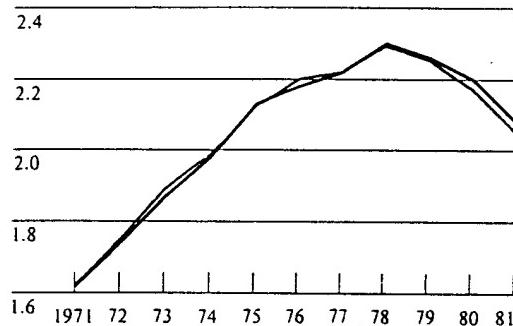
Note changes in scale

— Actual

— Simulated

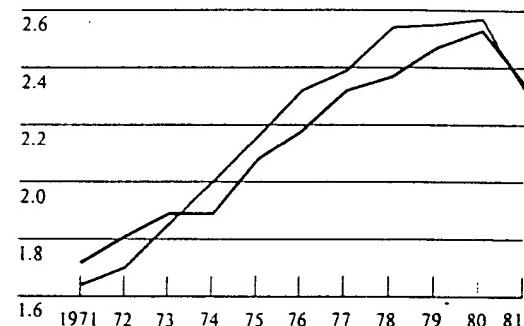
GNP

Trillion 1977 domestic zlotys



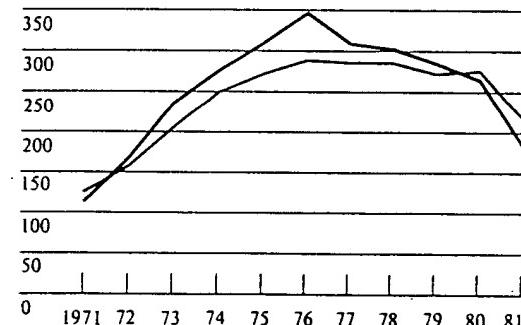
Apparent energy consumption

Million barrels per day oil equivalent



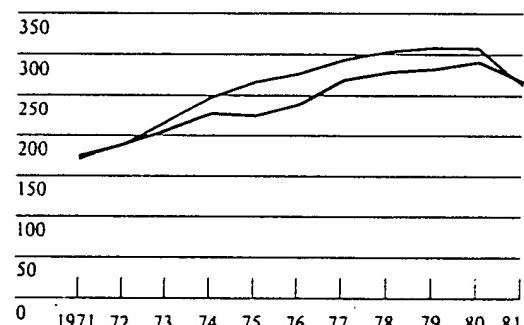
Hard currency imports

Billion 1977 domestic zlotys



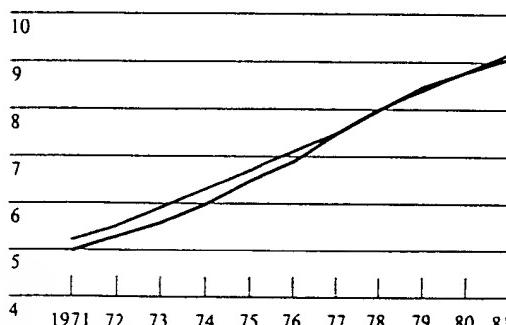
Soft currency imports

Billion 1977 domestic zlotys



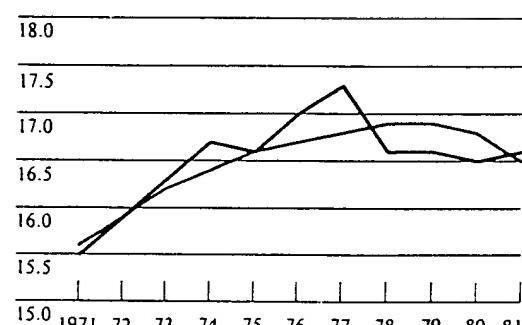
Capital stock

Trillion zlotys of 1 Jan 1977



Employment

Million workers



controlled by Polish policymakers. The degree of control varies from government expenditures, which are controlled, to exports, which can be reduced by fiat but not increased unless foreign markets can be found. Domestic and foreign policies or significant economic events imply various combinations of these variables. The reaction of POLGNP to hypothetical policy changes and especially to external events described by shifts in particular variables can be extremely useful in determining the path of the economy's adjustment to such changes as well as in further evaluating the model itself. Such projections are called conditional forecasts.

The potential impact of particular events or policy changes is usually assessed by comparing two model projections, a reference case and a case incorporating the assumed changes in terms of shifts in parameters or exogenous variables. As a reference case, we developed a baseline projection of demands placed on the Polish economy from 1982 to 1990. The key assumptions for 1982 are shown in table 1.

Results of the Baseline Simulation, 1982-90

1982. This was a year of both dramatic decline in aggregate demand and shift in its composition away from domestic end uses and toward exports. The assumed decline in domestic end uses of 10.5 percent and the rise in exports of 9.4 percent resulted in a drop in GNP of only 6.8 percent; total imports decline 9.1 percent due to a drop in imports from socialist countries of 9.8 percent and from hard currency trading partners of 8.3 percent.

Increases in hard currency imports are concentrated on energy (92 percent), chemicals (17 percent), wood and paper products (1,606 percent), light industrial products (23 percent), and miscellaneous industrial products (37 percent). POLGNP reflects a rebound in the Polish economy's needs for these hard currency imports after sharp reductions in 1980 and 1981. Soft currency imports in 1982 also register some increases: mineral products, miscellaneous industrial products, and agricultural products. The following domestic sectors also gain despite the overall decline in GNP: coal, oil, machinery, precision instruments, livestock products, housing, and government.

Table 1
Key Assumptions for 1982

1982 End Uses *	Growth Rate	Percent
All domestic end uses	-10.5	
Personal consumption, food	-7.2	
Personal consumption, housing	4.0	
Personal consumption, other	-19.1	
Investment	-18.5	
Government, civilian	4.0	
Government, defense	5.4	
Additions to inventories	-20.5	
Exports	9.4	
1982 Export Commodity Groups *	Share in 1981 Total Exports	Assumed Share in 1982 Total Exports
Energy	8.0	11.8
Machinery and construction	55.2	53.8
Metals	7.7	6.8
Chemicals	8.3	7.9
Wood and paper	2.6	2.0
Light industry	8.7	7.4
Processed foods	5.5	6.4
Other categories	No change from 1981	

Assumptions 1983-85. All domestic end use and export categories are assumed to hold constant at their 1982 levels.

Assumptions 1986-90. All domestic end use and export categories are assumed to grow 1 percent per year.

Weather. Normal weather is assumed throughout the period 1982-90.

* Although based on the best available data, these assumptions may not reflect what actually occurred in 1982. The need to convert all data to 1977 domestic zlotys with provisional deflators and conversion factors increases the likelihood of revisions once formal data are available.

Capital stock in 1982 registers an increase of 4.3 percent despite the decline in GNP, an occurrence with historical precedent in Poland in 1979-81. The requirement for labor, on the other hand, falls, but only slightly. Energy use declines even more than

GNP, 10.5 versus 6.8 percent, due to dramatic decreases in the need for both coal and oil and because the most energy intensive components of demand fell more than the less energy-intensive components. In terms of domestic uses, the largest declines were in investment (-18 percent) and other personal consumption, including durables (-19 percent). Food consumption only fell 7 percent while housing consumption increased 4 percent. The big losers in terms of total exports were machinery, metals, and chemicals. ■■■

1983-90. The exogenous variables are assumed to be stable through 1990. No changes are assumed in 1983-85, and all 12 export categories and seven domestic end uses grow at 1 percent per year during 1986-90. These assumptions allow POLGNP to settle down and reflect undercurrents of technological change without further shocks. ■■■

The first major conclusion is that, with constant demand, GNP declines by 0.2 percent average per year as the economy substitutes imports for domestic value added. Furthermore, when demand grows by 1 percent per year, GNP grows by 0.73 percent. POLGNP reflects the historical tendency of the Polish economy to meet increases in demand with an import response (unless constrained by hard currency availability) rather than domestic production and indicates that this tendency changes slowly. The sectors in which value added declines the most with stagnant demand are:

Domestic Sector	Percentage Range of Annual Decline
Coal	-4.2 to -2.0
Electricity	-3.5 to -2.5
Nonferrous metals	-4.1 to -2.0
Wood products	-7.0 to -2.5
Miscellaneous material products and services	-2.2 to -2.0

These domestic sectors would lose domestic markets to imported substitutes without financial constraints on imports. Imported oil and gas, for example, would

substitute for domestic coal and electricity. The following domestic sectors, however, would grow appreciably by substituting their outputs for competing imports under stagnant demand conditions:

Domestic Sector	Percent Range of Annual Growth
Chemicals *	-0.7 to 3.8
Paper	0.4 to 1.7
Textiles	0.6 to 2.4
Clothing	0.6 to 2.8
Leather products	0.2 to 1.9
Agriculture	-1.5 to 3.8

* The performance of the domestic chemicals industry, in particular, is interesting. It is able to resist loss of domestic markets to imports in periods with great demand fluctuations (see appendix C) and gains market share against imports in periods of steady stagnant demand. ■■■

Even with no change in the level and composition of aggregate demand, imports rise. While soft currency imports rise by about 1 percent per year during 1983-85, hard currency imports decline 1.2 percent in 1983, then rebound with a 4.6-percent increase in 1984 and a smaller 0.4-percent increase in 1985. Most of this growth is due to growth in energy and machinery hard currency imports. ■■■

Capital stock in POLGNP continues to increase 5.4 percent per year even in a stagnant economy—a continuation of the past tendency to accumulate capital regardless of economic conditions. Labor requirements decline with GNP, but at one-half to two-thirds the rate. Energy consumption, on the other hand, drops by up to 3 percent each year during 1983-85, reflecting both conservation and substitution of gas for coal and oil. ■■■

When demand growth picks up to 1 percent per year in 1986-90, GNP begins to grow but only three-fourths as fast as demand. Some sectors—coal, electricity generation, machinery, and electrical equipment—continue to contract moderately as they continue to lose domestic customers to imported substitutes. Total imports increase an average 2.2 percent

per year bolstered by a 3.6-percent jump in hard currency imports in 1986. Hard currency import growth slows to 2 percent in 1987, recovers slightly to 2.3 percent in 1988, and then subsides to 1.8 percent in 1989 and 1990. This variation in growth occurs even when demand growth is steady at 1 percent per year. POLGNP has picked up a rhythm in Polish hard currency imports: their growth picks up in 1984, 1986, and 1988 and slows somewhat in the intervening years. Soft currency imports, on the other hand, tend to grow more slowly and steadily. This behavior apparently reflects reliance on hard currency imports as a quick response to increases in demand, and then a corresponding slowdown in the following year, with a similar rebound in growth in the third year. Over time, this cyclical pattern in hard currency imports continues but diminishes. This minicycle in the growth of hard currency imports has historically been overwhelmed by the normal fluctuations in the level and composition of demand in the Polish economy. The minicycle only becomes apparent when disturbances to steady growth have been removed. ■

With 1-percent growth in aggregate demand during 1986-90, the stock of capital increases on average by 5.6 percent per year, required employment by less than 0.2 percent per year, and energy use by less than 0.1 percent per year. The low growth rate for energy use displays an interesting time pattern, with energy use actually declining in 1986 and 1987 and turning slightly positive in 1988-90. This pattern results from the substitution of gas for coal, which accumulates to 150,000 barrels per day oil equivalent between 1985 and 1990. ■

The Importance of the Composition of Demand

To demonstrate the importance of the composition of demand, POLGNP has been resimulated over the 1982-90 period after changing the underlying assumptions. The new assumptions are given in the two following scenarios:

- **1970 Demand Composition Scenario.** The shares of the 19 components of aggregate demand during 1983-90 are set at their 1970 shares. Over the period 1970-81, 1970 had the lowest hard currency imports/GNP ratio (0.06).

- **1976 Demand Composition Scenario.** The shares of the 19 components of aggregate demand during 1983-90 are set at their 1976 values. Over the period 1970-81, 1976 had the highest hard currency imports/GNP ratio (0.159).

Two key assumptions, however, were not changed:

- In 1982 baseline values were used for the exogenous variables—12 export categories, seven domestic end uses, and weather conditions. Thus, for 1982 the baseline and two alternative scenarios are identical.
- In 1983-90 the baseline value for aggregate demand—total exports plus total domestic end uses—was used. *Thus, differences between the scenarios and the baseline stem only from differences in the composition of aggregate demand.* Besides demonstrating the use of POLGNP, these scenarios also help gauge the importance of shifts in composition of aggregate demand with the level held constant in determining Poland's import needs. ■

The assumptions for the two scenarios above may be compared with each other and the baseline assumptions in table 2. The impact of changes in the composition of aggregate demand on annual growth rates of key variables—and the variability of those growth rates over time—are shown in figure 4. Summary results are given in table 3. This table and figure 3 make the following important points:

- First, the growth rates of key variables are sensitive to the composition of aggregate demand as well as its growth rate, and the composition is critical in determining resource requirements. The average annual rate of growth of GNP differs by 0.6 percentage point across the scenarios; that for hard currency imports by 0.5 point; the rate for soft currency imports by 3.3 points; and that for energy consumption by 0.6 point.
- Second, the baseline scenario with the smallest share of demand allocated to investment has the highest growth rate of GNP. This contrasts with

Table 2
Component Shares of Total Aggregate Demand Assumed for Three Scenarios, 1983-90

	1970 Demand Composition Scenario	1976 Demand Composition Scenario	1982 Demand Composition Scenario (Baseline)	Percent
Export share in aggregate demand	15.0	16.5	19.6	
Share in total exports	100.0	100.0	100.0	
Energy	20.9	17.7	11.8	
Metals	8.0	6.2	6.8	
Machinery	31.8	41.4	53.8	
Chemicals	7.8	8.6	7.9	
Minerals	0.8	0.8	0.9	
Wood and paper	4.4	2.6	2.0	
Light industry	8.1	9.2	7.4	
Processed foods	11.6	9.4	6.4	
Other industry	0.7	0.5	0.6	
Agricultural products	5.3	2.9	1.7	
Forest products	0.6	0.5	0.6	
Other products and services	0.1	0	0.2	
Domestic end use share in aggregate demand	85.0	83.5	80.4	
Share in total domestic end uses	100.0	100.0	100.0	
Personal consumption				
Of which:				
Food	23.1	21.6	24.9	
Housing	11.1	8.8	13.1	
Other	23.5	22.7	21.3	
Investment	23.0	30.2	20.4	
Government				
Of which:				
Civilian	9.3	7.3	10.6	
Defense	4.7	3.3	4.6	
Additions to inventories	5.3	6.1	5.0	

supply driven models in which investment increases capital stock, which in turn increases GNP. In Poland, however, lags in commissioning new capital and variable retirement rates have broken the close connection between investment and capital stock.

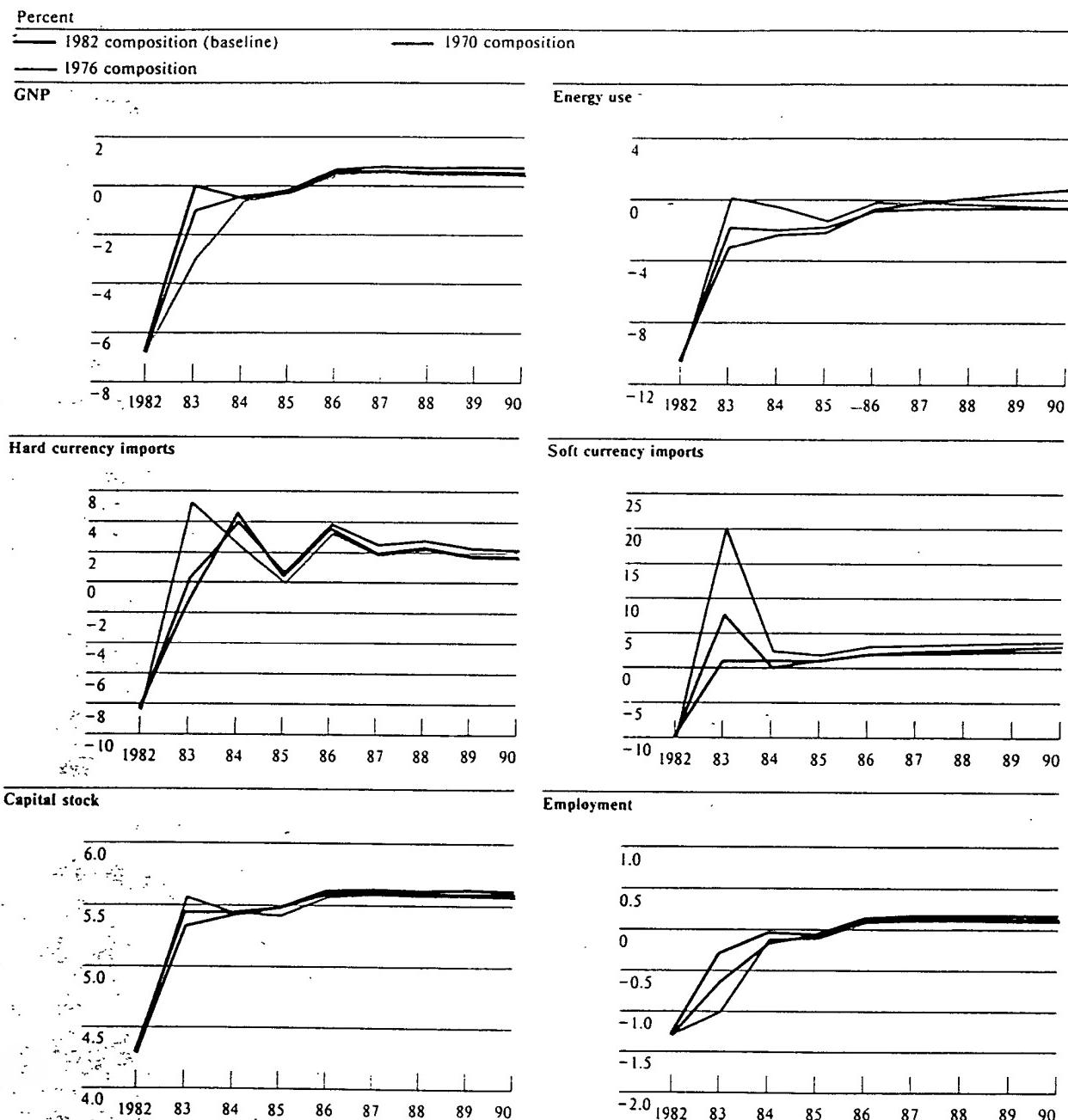
Table 3
Average Annual Percentage Growth Rates, 1983-90

Variable	1970 Demand Composition	1976 Demand Composition	1982 Demand Composition (Baseline)
GNP	0.0	-0.2	0.4
Hard currency imports	2.4	2.3	1.9
Soft currency imports	2.7	5.0	1.7
Capital stock	5.5	5.5	5.6
Employment	0.0	-0.1	0.1
Domestic energy consumption	-1.0	-0.4	-0.9

Moreover, Polish investment relies heavily on imported, as opposed to domestic, machinery and construction. Thus, increasing investment at the expense of other end uses, such as consumption, increases imports at the expense of domestic production. This reduces GNP.

- Third, neither capital stock nor employment shows any sensitivity to changes in the composition of demand; if capital utilization and effective labor, however, could be measured and simulated, we believe, they would show more variability.
- Finally, the baseline simulation with its aggregate demand composition approximating the 1982 actual composition is the scenario that involves the lowest growth in hard currency imports. It shows the highest GNP growth with minimum import growth and is even more suitable for the realities of the 1980s than the output mix of 1970, the year with the lowest historical hard currency import/GNP ratio.

Figure 4
Comparison of Three Scenarios: Annual Growth Rates



Applying POLGNP

The simulations done with POLGNP indicate that an econometric model of this kind, which links sectoral GNP with foreign trade detail, is a reliable and useful tool in studying how an economy adjusts to a changing economic environment. POLGNP provides a consistent framework for investigating the effects of alternate levels and compositions of aggregate demand and for examining the linkages between these demands and the economy's supply responses. The few scenarios reported here indicate that significant adjustments have taken place in the Polish economy in the late 1970s and particularly in 1981. Any projection for the future must take these adjustments into account. ■■■

Applications of POLGNP to growth studies will help to analyze the long-term prospects for Polish economic recovery. The model can be applied to alternate demand scenarios to indicate the differences in capital, labor, and energy requirements; the shift among hard currency and soft currency imports and domestic supplies of goods and services; and their impacts on Polish recovery and growth potential in the 1980s. These studies based on applications of POLGNP will serve as a comprehensive description of the range of Polish economic options, Polish flexibility in the face of shifts in resource availability (particularly with respect to oil and hard currency imports), and other economic problems facing Polish policymakers. ■■■

In the long run, the usefulness of POLGNP can be enhanced by further developments, especially in four specific areas: data, specification, historical study, and comparable models for other countries. First, the data on which POLGNP is based are detailed GNP and foreign trade accounts converted to constant domestic zlotys. Neither the domestic GNP nor the foreign trade accounts used in this paper are provided by Polish statistical offices; both are the results of groundbreaking efforts to generate these accounts. While this work was done as carefully and thoroughly as feasible, given time and resource constraints, a second data development effort building on the initial one is likely to improve the quality of the data substantially. Moreover, the Polish economy is being forced to undergo some dramatic technological transformations. While POLGNP is designed to be sensitive to changing technological relationships, an econometric model estimated on historical data cannot

project economic relationships that have no historical precedent. In order to model the Polish economy accurately, each additional year of data is important and could improve the model's performance. ■■■

Second, further historical study of the Polish economy is essential. While several published assessments of the Polish economy in the 1970s are available, none benefited from this study's use of input-output data and detailed GNP accounts with fully integrated and consistent domestic economic and foreign trade relationships. Historical study using this data will shed considerable light on the ability of the Polish economy to undergo technological transformation. ■■■

Third, specification of the equations in POLGNP is extremely important. The "workhorse" equation estimates the supply response of each sector as a function of demand for that sector's output as derived from the input-output table and a single-lag autoregressive correction term. This specification has served quite well, but others might serve better. One prime candidate is a first-difference equation without the autoregressive correction term. Nothing is yet known about the effects of this and other possible specifications when embedded in a model such as POLGNP in which endogenous variables are adjusted relative to the standard errors of their estimating equations to force compliance with accounting constraints. ■■■

Fourth, construction of comparable models for other countries will help us better understand both the technological transformations occurring in these countries and the internal workings of detailed GNP models of the POLGNP type. Hungary, with its reputation for managerial flexibility and technological innovation, would be particularly interesting for comparison purposes. ■■■

Finally, in POLGNP, questions of the level and composition of aggregate demand—domestic end uses and exports—are handled outside the model, but they obviously have a strong bearing on the character of any analysis conducted with the model. We need to improve our understanding of the determinants of these variables in order to upgrade our analysis of the Polish economy and its prospects. ■■■

Appendix A

Structure and Methodological Innovations¹³

POLGNP departs in several important ways from conventional analytical practice to enhance the reliability of projections. The heart of POLGNP and the first departure from conventional practice is the modified input-output table. The restructured 1977 Polish table has 58 sectors; the first 34 are domestic sectors such as the machinery sector or agricultural livestock sector. The innovation in POLGNP's input-output table is that gross imports are explicitly represented by rows and columns in the transactions matrix. The last 24 rows and columns are for imports divided into commodity categories: 12 for capitalist and 12 for socialist imports. The usual place for imports in input-output tables is a column of negative entries in the final demand quadrant. Thus, they are subtracted from the demands placed on the economy before any analysis begins. Moving them to the transactions matrix fully integrates them into the analysis of the economy's supply responses. Then, by using standard input-output techniques, the supply side requirements including imports are derived with the assumption of constant technology inherent in the input-output table. This is very different from the treatment accorded imports in standard input-output analysis. ■■■

The second innovation in POLGNP is a three-stage estimation of almost all the endogenous variables. The estimation problem is broken down into components. The myriad factors affecting each supply response variable are separated into three categories: (a) macroeconomic factors—the level and composition of domestic and export demands on the demand side of GNP—with technology held constant; (b) patterns of technological response to changes in demand; and (c) technological change that occurs for other reasons. ■■■

(a) The effects of macroeconomic factors assuming constant technology are measured by first calculating each supply side variable through the input-output table. The modified 1977 Polish input-output table is partitioned with two parts used here. (See figure 1 in

text.) The upper-left 58-by-58 rows and columns, the transactions matrix, is converted into the direct coefficient or A matrix by dividing each element in every column by the total output of that column's sector. The direct-plus-indirect coefficient matrix (also called the Leontief or $(I-A)^{-1}$ matrix) is then derived via the standard matrix algebra calculations. The upper-right 58 rows and 19 columns (seven domestic end uses and 12 export categories) are converted to a final demand composition matrix by dividing each element in each column by its column total. Thus, each element is the share of each output, domestically produced or imported, in that column's final demand category in 1977. By multiplying these final demand composition columns by their corresponding end uses or exports for each year and then summing across rows, we calculate the direct deliveries to total final demand from each supplying sector for the given year; for each year, this is a 58-by-1 column vector. Multiplying this column vector by the $(I-A)^{-1}$ described above yields gross production or imports for each of the 58 supplying sectors. The domestic supplying sectors are then multiplied by their respective 1977 value added/gross output ratios for 1977 to convert them to GNP value added figures. The result is a calculation for each year of what domestic value added and imports would have been if the Polish economy had been frozen in base year 1977 technology as reflected in the input-output table. Only technological change away from the 1977 level of technology remains to be estimated. This procedure substantially reduces the explanatory burden borne by the estimated equations that follow. Each of these calculated supply side values then becomes the chief independent variable to estimate the pattern of technological change affecting this supply side component. ■■■

(b) The pattern of technological change affecting each supply side variable is estimated by applying standard regression techniques to an equation estimating the

¹³ See the general flow diagram of POLGNP. The data bank, input-output table, and equation listing are available from the author on request, 351-5167. ■■■

supply response of each sector as a function of demand for that sector's output as derived from the input-output table and a single-lag autoregressive correction term. ■

$$\text{SSV}_i = e^{A1} \cdot (\text{CSSV}_j)^{A2} \cdot (\text{SSV}_i(-1)/\text{CSSV}_i(-1))^{A3}$$

where

e = the base of natural logarithms

SSV_i = supply side variable i

CSSV_i = calculated value of supply side variable i from (a)

$A1, A2, A3$ = estimated coefficients.¹⁴ ■

(c) Technological change—other than technological change in response to changes in demand—is accounted for when the GNP accounting constraint is imposed. The supply side of GNP must equal the demand side, but the supply side component estimates from equations like those in (b) above are unlikely to add up to precisely the right number. Each must be adjusted somewhat to ensure that the GNP constraint is obeyed. But which ones should be adjusted and by how much? Furthermore, which supply side components are most likely to be affected by technological surprises, that is, by deviations from the supply side responses predicted by the equations in (b) above? The best indicators of the relative likelihood of technological change not otherwise accounted for are the standard errors of the regressions used to estimate the equations in (b) above. The *standard error* is a statistical measure of the degree to which an equation's forecasts would have been in error due to factors not in the equation if it had been used to forecast in the past. In this case, a higher standard error indicates change other than that in response to demand changes. So, POLGNP adjusts the projections of the supply side variables in proportion to the standard errors of the equations estimating those variables. These adjustments ensure both that the basic GNP accounting identity is fulfilled (supply side equals demand side) and that the effects of non-demand-responsive technological change, that is, deviations from the supply side responses predicted by the equations in (b) above, fall most heavily on those variables with a history of non-demand-responsive technological change. ■

¹⁴ The closer $A2$ is to unity, the closer the economy is to constant technology with regard to the supply response of sector i to changes in demand. The closer $A3$ is to unity, the more closely the technological change in supply response matches the technological change in the previous year. ■

This three-stage procedure is applied first to 13 commodity categories which combine domestic activity and imports and then to the 34 domestic producing sectors and 24 import categories which make up the 13 commodity categories. The third innovation in POLGNP is the two-stage treatment of technological change. Technological change occurs for many reasons and has many economic effects. In this approach, those effects are separated into two categories: technological adjustments in the use of the 13 commodity categories regardless of origin and technological adjustments in the use of the components within each of the 13 categories. These components include one or more domestic products or services, a component for related hard currency imports, and a component for related soft currency imports. ■

POLGNP deals first with the technological change unrelated to product origin. The supply side of GNP is divided into 13 major input categories, such as energy, metals, and chemicals. Each category contains the complete supply side response for its product type; thus, chemicals includes both value added in the domestic chemicals industry, gross value of hard currency imported chemicals, and gross value of soft currency imported chemicals.¹⁵ POLGNP first determines the supply side response for each of these 13 composite input categories as a whole. ■

After this calculation, each input category is disaggregated into one or more domestic sectors and hard and soft currency imports, and adjustments relating to product origin—domestic, hard currency, and soft currency—are calculated. Total hard currency imports are, thus, the sum of hard currency imports for each of 12 product categories—with substitutability in each category calculated separately. ■

Only after the complete calculation of all 34 domestic sectors and 24 import categories of the supply side of GNP are the economy's requirements for capital, labor, and energy (coal, oil, gas, and hydro/nuclear) calculated. Thus, the fourth and final innovation in

¹⁵ Though perhaps counterintuitive, to sum domestic value added with gross value of imports is logical within the GNP accounting framework. ■

POLGNP is the derivation of primary input demand: capital, labor, and domestic energy requirements by fuel type from the full detail GNP accounts derived earlier in the model, rather than from aggregate GNP or other aggregate variables. The effects of economic growth, changes in the composition of GNP, and technological change (that reflected in the changing coefficients of the $(I-A)^{-1}$ of the input-output table) have been handled in POLGNP. All that remains is to estimate the aggregate effects of changes in the direct capital, labor, and fuel input per unit output for each supply side (and for fuels and hydropower, domestic demand side) component of GNP. This is accomplished analogously to the three-stage estimating procedure described above in steps (a), (b), and (c).

(a) Capital, labor, coal, oil, gas, hydro/nuclear, and total energy requirements are calculated using constant coefficients measuring direct factor input per unit value-added derived from the input-output table and the corresponding values of the GNP components. (b) These constant technology total requirements for capital, labor, and the five energy variables then become the major independent variables in equations analogous to those described above for the supply side components of GNP. These equations estimate the pattern of technological change in direct capital, labor, and energy input per unit value added in the domestic supply side components of GNP.¹⁶ (c) The five energy variables must obey an energy accounting identity: total energy consumption must equal the sum of consumption of coal, oil, gas, and hydro/nuclear. This is accomplished by adjusting the elements of both sides of this identity toward each other in proportion to the standard errors of the estimated equations for each of them described above. ■■■

¹⁶ For the energy variables, the direct fuel input per unit value expenditure on each domestic end use must also be included. ■■■

Appendix B

Data Sources and Development

Cross-Section Data

POLGNP combined information from several sources to obtain a detailed picture of the technological relations in the Polish economy for the base year of the model, 1977. The official Polish input-output table for 1977 has been published in two versions in the annual Polish economic handbook, *Rocznik Statystyczny*, for 1980 and 1981. Extensive reworking and combining of the information in the tables is documented in *Research Program on East European Defense Economics: First Phase-Construction of a Polish Econometric Model, Part I: Introduction to POLMOD1*, appendixes A and B, Wharton Econometric Forecasting Associates, May 1982. The import rows and columns for the input-output table used in POLGNP were created using information in Bronislaw Wojciechowski, "Import Intensiveness of the Polish Economy: General and (Industrial) Subsector Problems," *Handel Zagraniczny*, No. 4, 1982, pp. 3-8.¹⁷ This restructuring of the input-output table involved disaggregation of the input deliveries in each row into at least three rows: one or more domestic input rows, a hard currency imports row, and a soft currency imports row. Within the import rows, deliveries to exports were reallocated proportionally to other uses except exports so that the table would not reexport imported goods. After the imports had been allocated to the domestic sector columns, composite sector uses of domestic transportation and domestic trade and distribution were divided proportionally to gross deliveries from the three supplying composite sector components: domestic sectors, hard currency imports, and soft currency imports.¹⁸ Thus, the cells in import-sector rows and the transportation and trade

¹⁷ The full description of the derivation of our modified input-output table will be made available upon request.

¹⁸ For example, assume deliveries of chemicals to all uses totaled 100 million zlotys—60 million in domestic chemicals, 30 million in hard currency imports, and 10 million soft currency imports—and chemicals used 10 million zlotys of domestic transport services. Then, assume 6 million zlotys of transport services were used to deliver domestic chemicals, 3 million to deliver hard currency chemical imports, and 1 million zlotys of domestic transport services to deliver soft currency chemical imports.

columns reflect an estimate of the use of these services to move and distribute imports within the country. After this expansion was completed, the table was collapsed by adding rows and columns to the 58-sector transactions matrix used in POLGNP.

Time Series Data

The construction of Polish GNP accounts is based on three sources: official Polish economic data, in particular the detailed annual national income information and the two versions of the 1977 input-output table provided in the 1980 and 1981 editions of *Rocznik Statystyczny*; sectoral indexes and weights generated by L. W. International Financial Research and published in their occasional papers OP-63, OP-64, OP-70, OP-71, OP-72, and OP-73; and foreign trade and end use disaggregation work by Wharton Centrally Planned Economies Projects published in their documentation of POLMOD1. The general approach taken here has been to follow indexes and weights developed by L. W. International Financial Research, imposing minimal changes to disaggregate the fuels and agriculture sectors and the residual end use category and to impose the constraint of a GNP accounting framework.

L. W. International Financial Research provides detailed sectoral indexes and 1977 sectoral weights in OP-64, table 5 and OP-70, tables 5 and 11. These indexes and weights were used with two exceptions. The fuels sector was replaced by separate oil and gas sectors with the weights proportional to 1977 oil and gas production in standard fuel units and with the indexes for each fuel proportional to production of that fuel over time. The second exception was that the agriculture sector was disaggregated into three sectors: crops, animal products, and services. The weights were derived from the value added for these three

sectors given in the input-output table with their sum constrained to equal the weight for aggregate agriculture in OP-70, table 5. The indexes were derived from agricultural output data in million 1977 zlotys in OP-71, table 5.1, which gives values of crops and animal products separately. The index for agricultural services was assumed to be proportional to their total.

The weights and indexes were then combined to yield total GNP and GNP by sector of origin for the years 1975 through 1980. The sector-of-origin components of GNP were calculated for the years 1970-74 based on branch-of-industry data provided by L. W. International Financial Research, sector indexes in table 5 of their OP-59, and agricultural output indexes in Gregor Lazarcik, "Comparative Growth, Structure, and Levels of Agricultural Output, Inputs, and Productivity in Eastern Europe, 1965-79," table 2, in *East European Economic Assessment*, volume 2, JEC, US Congress, 27 February 1981, p. 594.

Total GNP indexes were provided in OP-70, table 5 for 1975 through 1981. These were combined with the 1977 GNP zloty total in OP-64, table 5 to yield total GNP for 1975-81 in 1977 zlotys. These total GNP figures differed slightly (never more than a few percent) from the sums over the sectors. The sector value addeds were then adjusted proportionally so that they precisely summed to total GNP in each year. The fruits of this mundane, but time-consuming, task are 34-sector GNP accounts in million 1977 domestic zlotys.

L. W. International Financial Research provides indexes and weights for the end use components of GNP in OP-72, tables 5 and 11 for the years 1975-80. End use components of GNP were calculated for the years 1970-74 based on indexes given in table 5 of OP-61, *Eastern Europe: Domestic Final Uses of Gross Product, Selected Years, 1965-79*, published by L. W. International Financial Research in 1980. The methodology used to disaggregate the residual component into investment, defense, and additions to inventories (described below) is the same for both periods: 1975-81 and 1970-74. One additional assumption, however, had to be made for 1970-74. Since OP-61 does not disaggregate nonhousing personal consumption into food and other, the same index was used for

both those components of domestic end use GNP for 1970-74.

Two major modifications were made in both periods. First, nonhousing personal consumption was further disaggregated into food consumption and other consumption using the relevant weights in 1975 zlotys given in table 11 and converting them into 1977 zloty weights. Second, the residual end use was disaggregated into fixed capital formation, defense, and additions to inventories. This disaggregation was based on time series for these three end use components developed at Wharton for POLMOD1 based on official Polish time series for investment and additions to inventories and Polish input-output tables in 1977. The series themselves are given in Volume III of the POLMOD1 report along with brief descriptions of their development. The defense time series indexes are based on data in *Military Expenditures in Eastern Europe, Post World War II to 1979*, by Thad P. Alton, Elizabeth M. Bass, Gregor Lazarcik, and Wassyl Znayenko published by L. W. International Financial Research, OP-63, 1980, table 4. The indexes were deflated by a weighted sum of various sectoral deflators with the weights based on the derived composition of the defense column of the 1977 input-output table. The derivation of that column is detailed in Volume I of the POLMOD1 report, appendixes A and B. In summary, in that source the residual expenditures column less derived investment and inventory change columns was disaggregated into civilian and military government expenditures using the corresponding columns in the 1972 US input-output table to calculate relative shares with adjustments made for the fact that a larger share of the Polish population is in the military. Thus, the defense column in the input-output table and the defense expenditures time series used in this project are not to be considered as actual Polish defense expenditures. They are merely reasonable approximations that are consistent with other Polish data and that provide a means of gauging the impact of changing defense burdens on Polish GNP and resource requirements. Extracting the defense series or the defense input-output column from the model and using them to support more detailed microanalysis of defense capabilities should not even be considered.

Three derived Wharton time series—expenditures on investment, on additions to inventories, and on defense—were adjusted proportionally so that in each year their sum equals total “residual” expenditures as derived from the residual sector time series indexes and 1977 weights published by L. W. International Financial Research. ■■■

All these end use indexes and 1977 end use weights were combined to yield end use GNP components in 1977 domestic zlotys. These components were then adjusted proportionally so that in each year the end use components summed precisely to the GNP produced in the domestic sectors plus net imports, thus imposing the consistency constraint of GNP accounting. ■■■

The foreign trade components of the GNP accounts used here are taken from work done by Jan Vanous and Charles Movit for POLMOD1. Their efforts involved laboriously deflating commodity categories in devisa (foreign trade) zlotys and converting them into domestic zlotys. Linkages with ruble soft currency and dollar hard currency trade statistics were also developed. The results of their efforts in 1977 domestic zlotys are adopted here to complete the GNP accounts. ■■■

Total capital stock and employment time series data were derived from various issues of *Rocznik Statystyczny*. Energy consumption data are based on National Foreign Assessment Center ER 79-10624 (December 1979), *Energy Supplies in Eastern Europe: A Statistical Compilation*; updates appear in the annual *Handbook of Economic Statistics*. ■■■

Appendix C

Historical Validation of POLGNP, 1971-81

POLGNP has been validated over the period 1971-81.¹⁹ This 11-year period is twice as long as the period over which POLGNP will normally be simulated and includes years of substantial disruption and change in the Polish economy. The longer the period of simulation, the more likely that any instabilities in the model will become obvious. The substantial disruption and change over the validation period test POLGNP's capacity to identify turning points. POLGNP's performance can be assessed by examining several error statistics. The mean or average error and the mean percentage error allow overestimates in some years to cancel out underestimates in other years. This gives an indication of how well the variable is tracked over the long term despite errors which cancel each other over intervening years. The mean error allows comparison of relative importance of errors across variables. The mean percentage error indicates the magnitude of each error relative to the magnitude of the true value of the variable. The most rigorous error measure is the root mean squared percentage error.²⁰ It magnifies the effect of particularly large errors by squaring them. Thus, we concentrate on the root mean squared percentage errors in our evaluation. (See table 4.) Note first that the errors for the 13 major product and service aggregates are quite small, 3 or 4 percent except for processed foods (9 percent), miscellaneous traded, nonindustrial products and services (7 percent), and miscellaneous industrial products (5 percent). The Polish economy, like other developed economies, has little ability to substitute among these major aggregates. Processed foods might well be categorized under agriculture as part of

¹⁹ One change in POLGNP was required to simulate over 1971-81. The balancing mechanism for miscellaneous nonindustrial traded goods and services was simplified to prevent POLGNP from generating negative gross imports of this small, volatile, hodge-podge category after eight years of simulation. The impact of this temporary specification on the rest of the model was barely noticeable.

²⁰ Method of calculation: (1) calculate the percentage error for each of the 11 years simulated; (2) square the percentage errors; (3) compute the mean or average value of the squared errors; (4) take the square root of this mean or average. This is the most demanding error statistic because plus and minus errors cannot average out over time, and large errors receive greater weight.

the food delivery system of the economy, with explicit recognition of the trade-offs between unprocessed foods from the agriculture sector and processed foods from industry.

For the 34 producing sectors of GNP, the root mean squared percentage errors average about 4 percent. GNP originating in oil production registers a high 22 percent. The Polish oil industry is extremely small and produces at its maximum regardless of changes in oil demand; hence, large errors are to be expected from a demand-driven forecast. The other standout root mean squared percentage error appears for miscellaneous nonindustrial material products and services, one of the residual domestic sectors for which demand is difficult to estimate.

The largest root mean squared percentage errors occur for imports: an average 57 percent for imports from capitalist countries and 20 percent for imports from socialist countries. In general, imports from capitalist countries in each category are less than imports from socialist countries and will have larger percentage errors. But the major cause of the higher errors is the limited ability of Poland to control the supply response to changes in demand for imported goods. Much of the error in imports from capitalist countries for each category occurs in 1981 when hard currency constraints forced a much sharper drop in those imports than would have been predicted simply from the drop in domestic end uses and exports. For example, the root mean squared percentage error for capitalist-originating imports of wood and paper products is 368 percent. If we calculate the same statistic for 1971-80 (omitting 1981), the root mean squared percentage error drops to 23 percent. The plunge in imports of wood and paper products from capitalist countries was made up by a large upsurge in imports of those products from socialist countries, and 1981 registers the highest error for wood and paper product

Table 4
Simulation Errors of Endogenous Variables,
1971-81

Million 1977 domestic zlotys

	Mean Error	Mean Percentage Error	Root Mean Squared Percentage Error	Largest Percentage Error in Any Year
Energy	1,461	1	3	6
Domestic value added				
Coal	1,576	3	9	16
Oil	57	7	22	40
Gas	58	0	5	-10
Electric power	92	-0	4	-6
Capitalist imports	602	24	66	206
Socialist imports	-923	-3	9	-18
Metals	-2,220	-1	3	6
Domestic value added				
Ferrous metals	-198	-1	4	-7
Nonferrous metals	-59	-1	3	-6
Metalworking	-16	-0	2	-3
Capitalist imports	-1,917	3	24	61
Socialist imports	-30	-0	3	5
Machinery	-5,941	-1	2	-4
Domestic value added				
Machinery	-768	-1	3	-7
Precision instruments	-150	-1	5	-9
Transport equipment	-1,998	-3	7	-13
Electrical equipment	-310	-1	4	-7
Construction	-408	-0	3	7
Capitalist imports	-21,903	-19	27	-38
Socialist imports	19,595	19	23	50
Chemicals	160	0	2	-4
Domestic value added				
Chemicals	-703	-1	3	-6
Capitalist imports	-231	-0	6	-10
Socialist imports	1,094	5	6	12
Minerals	-342	-1	2	-4
Domestic value added				
Construction materials	-370	-1	3	-7
Glass and ceramics	24	0	5	9
Capitalist imports	43	5	20	43
Socialist imports	-39	1	14	38
Wood and paper	142	0	3	5
Domestic Value Added				
Wood and forest products	689	3	4	8
Paper	13	0	2	4
Capitalist imports	-563	94	368	1,220
Socialist imports	3	2	12	-32
Light industry	-227	-0	3	9

Table 4 (continued)

Million 1977 domestic zlotys

	Mean Error	Mean Percentage Error	Root Mean Squared Percentage Error	Largest Percentage Error in Any Year
Domestic value added				
Textiles	-217	-0	2	5
Clothing	-57	-0	2	5
Leather and shoes	-3	0	2	-6
Capitalist imports	28	4	20	47
Socialist imports	23	1	11	-18
Processed foods	2,906	4	9	-20
Domestic value added				
Processed foods	-3,283	-4	8	-18
Capitalist imports	8,500	37	43	67
Socialist imports	-2,300	-19	46	-104
Other industry	14	0	5	8
Domestic value added				
Other industry	-11	-0	3	-7
Capitalist imports	34	6	26	60
Socialist imports	-9	2	17	53
Agriculture	-107	0	1	2
Domestic value added				
Crops	-255	-0	1	2
Animal products	-32	-0	5	-11
Services	1	0	3	-7
Capitalist imports	117	2	13	34
Socialist imports	62	12	40	86
Forestry	23	0	4	-9
Domestic value added				
Forestry	24	1	5	-11
Capitalist imports	-4	10	5	88
Socialist imports	3	4	19	50
Nontraded services	477	0	1	3
Domestic value added				
Transport and communications	343	0	2	4
Domestic trade and distribution	222	0	2	4
Housing	-115	-0	1	-2
Government				
Of which:				
Investment in human capital	5	0	1	-2
Health and human services	-11	0	2	3
Administration and military	32	0	2	4

Table 4
Simulation Errors of Endogenous Variables,
1971-81 (continued)

Million 1977 domestic zlotys

	Mean Error	Mean Percentage Error	Root Mean Squared Percentage Error	Largest Percentage Error in Any Year
Other traded products and services	3,646	4	7	12
Domestic value added				
Other material products and services	4,518	7	11	19
Financial and other nonmaterial services	-861	-3	6	-13
Capitalist imports	-1	6	36	73
Socialist imports	-10	-16	44	75
Gross domestic product	-2,172	-0	1	-1
Total imports	2,161	0	3	7
From capitalist countries	-15,296	-4	11	18
From socialist countries	17,457	7	9	19
Domestic energy consumption a	39,370	2	5	7
Coal a	28,753	1	4	7
Oil a	3,822	1	5	-9
Gas a	5,240	3	6	10
Primary electricity a	924	168	530	1,755
Domestic capital stock b	145	2	3	6
Employment c	-12	-0	1	-3

a In thousand barrels per day oil equivalent.

b Million domestic zlotys of 1 January 1977.

c Thousand full-time worker equivalents.

imports from socialist countries and is largely responsible for the 12-percent root mean squared percentage error in that category in the table. ■■■

This analysis applies to almost all of the other categories. The errors for imports are higher than those for domestic value added, especially in 1981, and are largely attributable to unprecedented substitutions away from imports from capitalist countries and toward imports from socialist countries. Significant by its omission from the list of product categories to which this analysis applies is chemicals. Evidently there are few substitution possibilities among chemicals produced at home, those imported from capitalist countries, and those imported from socialist countries. The supply of chemical inputs from each of these three sources must go up and down closely with the technically determined demand for them. ■■■

The relatively high root mean squared percentage errors for imported inputs are troublesome since they indicate the measure of our knowledge and ignorance about the hard currency import dependence of the Polish economy. Nevertheless, the source of those errors points to a very important conclusion. Because of the international financial crisis, the decline in Poland's hard currency imports in 1981 was much greater than would be expected given: (1) its drop in economic activity in 1981, (2) the changing composition of its domestic end uses and exports, and (3) past trends in import dependence. Hence, we believe the technological structure of the Polish economy shifted abruptly in 1981 away from dependence on hard currency imports. We do not know how permanent the shift is or the extent to which it might be due to hard currency imports still in the pipeline to final users. ■■■

The payoff to modeling the sector detail in POLGNP is indicated in the last 11 lines of the table, where the errors for key aggregate variables are reported. The root mean squared percentage error for gross domestic product—Poland's reliance on domestic production rather than imports—is only 1 percent. The same statistic for overall import dependence is only 3 percent. The mean percentage errors—which allow overestimates and underestimates to cancel—for GDP and imports are 0 percent indicating a very accurate long-run picture of trade-offs in Poland between domestic and imported goods and services. The split of imports between capitalist and socialist sources is less accurate with root mean squared percentage errors of 11 and 9 percent, respectively. ■■■

The performance of the equation system in predicting domestic usage of energy, capital, and labor is good (root mean squared percentage errors of 1 to 5 percent). The exception is hydroelectric power (530 percent), which depends on water levels rather than demand. ■■■

Appendix D

Baseline Simulation

The following tables demonstrate the major strength of POLGNP—modeling a fully consistent, highly detailed set of GNP and foreign trade accounts. Assumptions about domestic end uses and exports indicate the degree of flexibility and detail which POLGNP can handle in specifying demands placed on the economy. The tables on domestic value added; hard currency imports; soft currency imports; and capital, labor, and energy requirements show in great detail the supply response necessary to fulfill these demands. By carefully comparing these needed supply responses to expected actual availabilities, potential bottlenecks can be identified—bottlenecks which would most likely be missed using more aggregated models. Because of rounding, components may not add to the totals shown. ■■■

Table 5
Baseline Simulation for
End-Use Components of Polish GNP

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Total end-use components	2,110,324.000	1,889,118.000	1,889,118.000	1,889,118.000	1,889,118.000
Percent change		-10.482	0.000	0.000	0.000
Share	1.000	1.000	1.000	1.000	1.000
Personal consumption, food	507,618.300	471,254.000	471,254.000	471,254.000	471,254.000
Percent change		-7.164	0.000	0.000	0.000
Share	0.241	0.249	0.249	0.249	0.249
Personal consumption, housing	238,274.000	247,805.000	247,805.000	247,805.000	247,805.000
Percent change		4.000	0.000	0.000	0.000
Share	0.113	0.131	0.131	0.131	0.131
Personal consumption, other	497,252.800	402,477.000	402,477.000	402,477.000	402,477.000
Percent change		-19.060	0.000	0.000	0.000
Share	0.236	0.213	0.213	0.213	0.213
Gross fixed capital formation	472,851.900	385,510.000	385,510.000	385,510.000	385,510.000
Percent change		-18.471	0.000	0.000	0.000
Share	0.224	0.204	0.204	0.204	0.204
Government, civilian	192,421.000	200,079.000	200,079.000	200,079.000	200,079.000
Percent change		3.980	0.000	0.000	0.000
Share	0.091	0.106	0.106	0.106	0.106
Government, defense	83,151.630	87,627.000	87,627.000	87,627.000	87,627.000
Percent change		5.382	0.000	0.000	0.000
Share	0.039	0.046	0.046	0.046	0.046
Additions to inventories	118,756.100	94,366.000	94,366.000	94,366.000	94,366.000
Percent change		-20.538	0.000	0.000	0.000
Share	0.056	0.050	0.050	0.050	0.050

Table 5 (continued)

Million 1977 domestic zlotys

	1986	1987	1988	1989	1990
Total end-use components	1,908,010.000	1,927,094.000	1,946,369.000	1,965,836.000	1,985,503.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	1.000	1.000	1.000	1.000	1.000
Personal consumption, food	475,966.600	480,726.400	485,533.700	490,389.100	495,293.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	0.249	0.249	0.249	0.249	0.249
Personal consumption, housing	250,286.900	252,793.600	255,325.400	257,882.600	260,466.000
Percent change	1.001	1.001	1.001	1.001	1.002
Share	0.131	0.131	0.131	0.131	0.131
Personal consumption, other	406,501.400	410,566.100	414,671.400	418,817.800	423,007.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	0.213	0.213	0.213	0.213	0.213
Gross fixed capital formation	389,365.200	393,258.900	397,191.500	401,163.500	405,175.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	0.204	0.204	0.204	0.204	0.204
Government, civilian	202,079.800	204,100.600	206,141.600	208,203.100	210,285.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	0.106	0.106	0.106	0.106	0.106
Government, defense	88,503.250	89,388.250	90,282.100	91,184.900	92,097.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	0.046	0.046	0.046	0.046	0.046
Additions to inventories	95,309.800	96,262.900	97,225.600	98,197.900	99,180.000
Percent change	1.000	1.000	1.000	1.000	1.000
Share	0.050	0.050	0.050	0.050	0.050
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Table 6
Baseline Simulation for Polish Exports

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Total exports	420,534.900	460,080.000	460,080.000	460,080.000	460,080.000
Percent change		9.404	0.000	0.000	0.000
Export/GNP ratio	0.202	0.237	0.237	0.238	0.239
Share	1.000	1.000	1.000	1.000	1.000
Energy	33,548.490	54,510.000	54,510.000	54,510.000	54,510.000
Share	0.080	0.118	0.118	0.118	0.118
Metals	32,422.280	31,110.000	31,110.000	31,110.000	31,110.000
Share	0.077	0.068	0.068	0.068	0.068
Machinery	232,259.100	247,380.000	247,380.000	247,380.000	247,380.000
Share	0.552	0.538	0.538	0.538	0.538
Chemicals	34,886.380	36,170.000	36,170.000	36,170.000	36,170.000
Share	0.083	0.079	0.079	0.079	0.079
Mineral products	3,765.000	4,150.000	4,150.000	4,150.000	4,150.000
Share	0.009	0.009	0.009	0.009	0.009
Wood and paper products	10,737.000	9,080.000	9,080.000	9,080.000	9,080.000
Share	0.026	0.020	0.020	0.020	0.020
Light industry	36,630.000	33,890.000	33,890.000	33,890.000	33,890.000
Share	0.087	0.074	0.074	0.074	0.074
Processed foods	23,089.080	29,240.000	29,240.000	29,240.000	29,240.000
Share	0.055	0.064	0.064	0.064	0.064
Other industry	2,682.699	2,960.000	2,960.000	2,960.000	2,960.000
Share	0.006	0.006	0.006	0.006	0.006
Agricultural products	7,280.000	8,030.000	8,030.000	8,030.000	8,030.000
Share	0.017	0.017	0.017	0.017	0.017
Forest products	2,553.199	2,810.000	2,810.000	2,810.000	2,810.000
Share	0.006	0.006	0.006	0.006	0.006
Other products and services	681.800	750.000	750.000	750.000	750.000
Share	0.002	0.002	0.002	0.002	0.002

Table 6 (continued)

	1986	1987	1988	1989	1990
Total exports	464,680.700	469,327.700	474,021.200	478,761.600	483,550.000
Percent change	1.000	1.000	1.000	1.000	1.000
Export/GNP ratio	0.240	0.240	0.241	0.241	0.242
Share	1.000	1.000	1.000	1.000	1.000
Energy	55,055.160	55,605.780	56,161.900	56,723.580	57,291.000
Share	0.118	0.118	0.118	0.118	0.118
Metals	31,421.110	31,735.320	32,052.680	32,373.210	32,697.000
Share	0.068	0.068	0.068	0.068	0.068
Machinery	249,853.800	252,352.400	254,875.900	257,424.800	259,999.000
Share	0.538	0.538	0.538	0.538	0.538
Chemicals	36,531.670	36,896.960	37,265.900	37,638.530	38,015.000
Share	0.079	0.079	0.079	0.079	0.079
Mineral products	4,191.559	4,233.531	4,275.926	4,318.746	4,362.000
Share	0.009	0.009	0.009	0.009	0.009
Wood and paper products	9,170.770	9,262.440	9,355.030	9,448.540	9,543.000
Share	0.020	0.020	0.020	0.020	0.020
Light industry	34,228.940	34,571.270	34,917.020	35,266.230	35,619.000
Share	0.074	0.074	0.074	0.074	0.074
Processed foods	29,532.490	29,827.900	30,126.270	30,427.630	30,732.000
Share	0.064	0.064	0.064	0.064	0.064
Other industry	2,989.601	3,019.497	3,049.693	3,080.190	3,111.000
Share	0.006	0.006	0.006	0.006	0.006
Agricultural products	8,110.367	8,191.539	8,273.523	8,356.328	8,440.000
Share	0.017	0.017	0.017	0.017	0.017
Forest products	2,838.033	2,866.347	2,894.942	2,923.823	2,953.000
Share	0.006	0.006	0.006	0.006	0.006
Other products and services	757.450	764.974	772.573	780.247	788.000
Share	0.002	0.002	0.002	0.002	0.002
[REDACTED]					

Table 7
Baseline Simulation for the Sector-of-Origin
Components of Polish GNP

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Total GNP	2,081,086.000	1,940,560.000	1,940,399.000	1,930,418.000	1,927,413.000
Percent change		-6.753	-0.008	-0.514	-0.156
Share	1.000	1.000	1.000	1.000	1.000
Coal	57,956.410	64,094.180	61,372.860	59,922.300	58,751.230
Percent change		10.590	-4.246	-2.364	-1.954
Share	0.028	0.033	0.032	0.031	0.030
Oil	1,083.425	1,114.707	1,117.888	1,127.367	1,130.129
Percent change		2.887	0.285	0.848	0.245
Share	0.001	0.001	0.001	0.001	0.001
Gas	14,456.440	12,682.860	12,484.730	12,458.280	12,407.700
Percent change		-12.268	-1.562	-0.212	-0.406
Share	0.007	0.007	0.006	0.006	0.006
Electricity	38,893.180	35,429.730	34,175.950	33,316.420	32,474.630
Percent change		-8.905	-3.539	-2.515	-2.527
Share	0.019	0.018	0.018	0.017	0.017
Ferrous metals	38,562.440	37,600.000	37,530.460	37,630.790	37,468.270
Percent change		-2.496	-0.185	0.267	-0.432
Share	0.019	0.019	0.019	0.019	0.019
Nonferrous metals	18,846.220	16,916.760	16,217.590	15,846.310	15,533.480
Percent change		-10.238	-4.133	-2.289	-1.974
Share	0.009	0.009	0.008	0.008	0.008
Metalworking	35,842.350	34,473.420	34,368.350	34,436.570	34,283.500
Percent change		-3.819	-0.305	0.198	-0.445
Share	0.017	0.018	0.018	0.018	0.018
Machinery	63,369.260	64,403.140	63,726.290	63,102.270	62,568.810
Percent change		1.631	-1.051	-0.979	-0.845
Share	0.030	0.033	0.033	0.033	0.032
Precision instruments	8,394.961	8,437.898	8,368.793	8,301.152	8,241.656
Percent change		0.511	-0.819	-0.808	-0.717
Share	0.004	0.004	0.004	0.004	0.004
Transport equipment	44,075.530	-43,044.720	42,971.950	42,805.700	42,603.650
Percent change		-2.339	-0.169	-0.387	-0.472
Share	0.021	0.022	0.022	0.022	0.022
Electric equipment	25,819.400	25,173.810	25,006.500	24,807.920	24,605.700
Percent change		-2.500	-0.665	-0.794	-0.815
Share	0.012	0.013	0.013	0.013	0.013
Chemicals	51,137.360	47,271.350	49,066.460	48,719.780	49,603.090
Percent change		-7.560	3.797	-0.707	1.816
Share	0.025	0.024	0.025	0.025	0.026
Construction materials	21,892.040	19,626.910	19,434.310	19,441.600	19,463.850
Percent change		-10.347	-0.981	0.037	0.114
Share	0.011	0.010	0.010	0.010	0.010

Table 7 (continued)

Million 1977 domestic zlotys

	1986	1987	1988	1989	1990
Total GNP	1,940,057.000	1,955,097.000	1,969,375.000	1,984,260.000	1,999,003.000
Percent change	0.656	0.775	0.730	0.756	0.743
Share	1.000	1.000	1.000	1.000	1.000
Coal	58,416.210	58,087.140	57,749.870	57,351.180	56,872.200
Percent change	-0.570	-0.563	-0.581	-0.690	-0.835
Share	0.030	0.030	0.029	0.029	0.028
Oil	1,141.465	1,147.946	1,151.057	1,150.895	1,147.882
Percent change	1.003	0.568	0.271	-0.014	-0.262
Share	0.001	0.001	0.001	0.001	0.001
Gas	12,519.140	12,617.800	12,706.670	12,777.670	12,830.000
Percent change	0.898	0.788	0.704	0.559	0.410
Share	0.006	0.006	0.006	0.006	0.006
Electricity	32,120.340	31,813.400	31,540.690	31,267.300	30,972.620
Percent change	-1.091	-0.956	-0.857	-0.867	-0.942
Share	0.017	0.016	0.016	0.016	0.015
Ferrous metals	37,733.980	37,928.390	38,132.200	38,341.100	38,569.660
Percent change	0.709	0.515	0.537	0.548	0.596
Share	0.019	0.019	0.019	0.019	0.019
Nonferrous metals	15,540.020	15,609.720	15,735.050	15,896.910	16,090.100
Percent change	0.042	0.449	0.803	1.029	1.215
Share	0.008	0.008	0.008	0.008	0.008
Metalworking	34,525.980	34,708.490	34,897.250	35,090.290	35,301.310
Percent change	0.707	0.529	0.544	0.553	0.601
Share	0.018	0.018	0.018	0.018	0.018
Machinery	2,628.770	62,632.240	62,606.840	62,556.290	62,482.500
Percent change	0.096	0.006	-0.041	-0.081	-0.118
Share	0.032	0.032	0.032	0.032	0.031
Precision instruments	8,268.566	8,293.797	8,319.254	8,344.172	8,367.938
Percent change	0.326	0.305	0.307	0.299	0.285
Share	0.004	0.004	0.004	0.004	0.004
Transport equipment	42,800.640	42,954.490	43,081.320	43,183.260	43,261.550
Percent change	0.462	0.359	0.295	0.237	0.181
Share	0.022	0.022	0.022	0.022	0.022
Electric equipment	24,610.210	24,569.420	24,495.960	24,394.160	24,267.360
Percent change	0.018	-0.166	-0.299	-0.416	-0.520
Share	0.013	0.013	0.012	0.012	0.012
Chemicals	49,790.250	50,691.840	51,062.950	51,680.140	52,142.670
Percent change	0.377	1.811	0.732	1.209	0.895
Share	0.026	0.026	0.026	0.026	0.026
Construction materials	19,721.730	19,976.170	20,228.050	20,467.870	20,694.930
Percent change	1.325	1.290	1.261	1.186	1.109
Share	0.010	0.010	0.010	0.010	0.010

Table 7
Baseline Simulation for the Sector-of-Origin
Components of Polish GNP (continued)

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Glass and ceramics	8,884.004	7,877.762	7,807.227	7,846.473	7,867.496
Percent change		-11.326	-0.895	0.503	0.268
Share	0.004	0.004	0.004	0.004	0.004
Wood products	24,914.880	19,688.980	18,319.890	17,649.340	17,215.780
Percent change		-20.975	-6.954	-3.660	-2.457
Share	0.012	0.010	0.009	0.009	0.009
Paper	7,192.477	6,357.477	6,383.992	6,549.477	6,662.535
Percent change		-11.609	0.417	2.592	1.726
Share	0.003	0.003	0.003	0.003	0.003
Textiles	48,076.080	44,236.710	45,288.750	45,969.770	46,228.590
Percent change		-7.986	2.378	1.504	0.563
Share	0.023	0.023	0.023	0.024	0.024
Clothing	17,345.370	16,030.850	16,473.690	16,738.030	16,836.140
Percent change		-7.579	2.762	1.605	0.586
Share	0.008	0.008	0.008	0.009	0.009
Leather products	14,528.710	13,327.990	13,581.530	13,721.230	13,742.070
Percent change		-8.264	1.902	1.029	0.152
Share	0.007	0.007	0.007	0.007	0.007
Processed foods	70,250.380	70,074.690	65,432.600	65,101.030	64,538.320
Percent change		-0.250	-6.624	-0.507	-0.864
Share	0.034	0.036	0.034	0.034	0.033
Other industry	15,428.780	13,997.800	13,561.950	13,491.800	13,429.140
Percent change		-9.275	-3.114	-0.517	-0.464
Share	0.007	0.007	0.007	0.007	0.007
Construction	118,004.400	99,048.700	96,375.600	97,126.300	96,677.700
Percent change		-16.064	-2.699	0.779	-0.462
Share	0.057	0.051	0.050	0.050	0.050
Agriculture, crops	593,380.600	513,535.100	533,206.800	525,467.800	528,378.300
Percent change		-13.456	3.831	-1.451	0.554
Share	0.285	0.265	0.275	0.272	0.274
Agriculture, animal products	7,526.496	7,891.168	8,099.754	8,098.426	8,107.383
Percent change		4.845	2.643	-0.016	0.111
Share	0.004	0.004	0.004	0.004	0.004
Agriculture, services	4,947.520	4,865.379	4,936.297	4,936.848	4,940.559
Percent change		-1.660	1.458	0.011	0.075
Share	0.002	0.003	0.003	0.003	0.003
Forestry	13,988.260	12,325.040	11,868.330	11,946.420	11,856.930
Percent change		-11.890	-3.706	0.658	-0.749
Share	0.007	0.006	0.006	0.006	0.006
Transport and communications	155,858.000	146,607.400	143,493.400	143,382.600	142,756.700
Percent change		-5.935	-2.124	-0.077	-0.437
Share	0.075	0.076	0.074	0.074	0.074

Table 7 (continued)

Million 1977 domestic zlotys

	1986	1987	1988	1989	1990
Glass and ceramics	7,965.480	8,047.875	8,124.824	8,196.121	8,264.543
Percent change	1.245	1.034	0.956	0.877	0.835
Share	0.004	0.004	0.004	0.004	0.004
Wood products	17,239.410	17,409.730	17,679.790	18,007.920	18,374.290
Percent change	0.137	0.988	1.551	1.856	2.034
Share	0.009	0.009	0.009	0.009	0.009
Paper	6,837.629	6,976.555	7,090.059	7,181.477	7,258.551
Percent change	2.628	2.032	1.627	1.289	1.073
Share	0.004	0.004	0.004	0.004	0.004
Textiles	46,753.980	47,146.560	47,498.950	47,828.140	48,151.050
Percent change	1.136	0.840	0.747	0.693	0.675
Share	0.024	0.024	0.024	0.024	0.024
Clothing	17,017.550	17,146.450	17,259.190	17,363.160	17,464.710
Percent change	1.077	0.757	0.657	0.602	0.585
Share	0.009	0.009	0.009	0.009	0.009
Leather products	13,851.250	13,930.930	14,009.050	14,085.900	14,164.200
Percent change	0.795	0.575	0.561	0.548	0.556
Share	0.007	0.007	0.007	0.007	0.007
Processed foods	65,181.260	65,697.560	66,332.810	66,959.940	67,609.250
Percent change	0.996	0.792	0.967	0.945	0.970
Share	0.034	0.034	0.034	0.034	0.034
Other industry	13,557.860	13,687.770	13,831.040	13,976.410	14,125.140
Percent change	0.958	0.958	1.047	1.051	1.064
Share	0.007	0.007	0.007	0.007	0.007
Construction	97,676.400	98,446.700	99,329.600	100,171.800	101,029.600
Percent change	1.033	0.788	0.897	0.848	0.856
Share	0.050	0.050	0.050	0.050	0.051
Agriculture, crops	528,998.600	532,351.100	534,669.900	537,390.500	539,951.300
Percent change	0.117	0.634	0.436	0.509	0.476
Share	0.273	0.272	0.271	0.271	0.270
Agriculture, animal products	8,153.617	8,188.055	8,215.590	8,242.242	8,266.074
Percent change	0.570	0.422	0.336	0.324	0.289
Share	0.004	0.004	0.004	0.004	0.004
Agriculture, services	4,971.000	4,994.797	5,015.234	5,035.082	5,053.801
Percent change	0.616	0.479	0.409	0.396	0.372
Share	0.003	0.003	0.003	0.003	0.003
Forestry	11,931.390	11,985.110	12,063.090	12,138.080	12,217.610
Percent change	0.628	0.450	0.651	0.622	0.655
Share	0.006	0.006	0.006	0.006	0.006
Transport and communications	145,221.300	147,872.300	150,814.300	153,866.500	157,027.700
Percent change	1.726	1.826	1.989	2.024	2.054
Share	0.075	0.076	0.077	0.078	0.079

Table 7
Baseline Simulation for the Sector-of-Origin
Components of Polish GNP (continued)

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Trade and distribution	125,514.000	112,059.600	110,652.200	110,896.600	110,689.000
Percent change		-10.719	-1.256	0.221	-0.187
Share	0.060	0.058	0.057	0.057	0.057
Other material products and services	69,126.690	65,021.000	63,743.920	62,406.510	61,009.640
Percent change		-5.939	-1.964	-2.098	-2.238
Share	0.033	0.034	0.033	0.032	0.032
Housing	203,017.400	213,605.300	213,145.600	213,992.000	214,029.900
Percent change		5.215	-0.215	0.397	0.018
Share	0.098	0.110	0.110	0.111	0.111
Other nonmaterial services	27,628.090	24,203.950	23,378.080	23,608.590	23,785.430
Percent change		-12.394	-3.412	0.986	0.749
Share	0.013	0.012	0.012	0.012	0.012
Government, human investment	61,265.240	62,390.660	62,197.750	62,414.960	62,420.500
Percent change		1.837	-0.309	0.349	0.009
Share	0.029	0.032	0.032	0.032	0.032
Government, health and human services	39,081.130	39,745.120	39,771.760	40,000.090	40,055.460
Percent change		1.699	0.067	0.574	0.138
Share	0.019	0.020	0.020	0.021	0.021
Government, administration and military	34,802.320	37,406.240	36,844.010	37,163.980	37,057.000
Percent change		7.482	-1.503	0.868	-0.288
Share	0.017	0.019	0.019	0.019	0.019
[REDACTED]					

Table 7 (continued)

Million 1977 domestic zlotys

	1986	1987	1988	1989	1990
Trade and distribution	112,431.400	114,162.900	115,996.700	117,849.400	119,738.100
Percent change	1.574	1.540	1.606	1.597	1.603
Share	0.058	0.058	0.059	0.059	0.060
Other material products and services	60,574.900	60,344.140	60,315.580	60,452.910	60,737.520
Percent change	-0.713	-0.381	-0.047	0.228	0.471
Share	0.031	0.031	0.031	0.030	0.030
Housing	216,545.600	218,727.500	220,863.900	222,936.900	225,004.900
Percent change	1.175	1.008	0.977	0.939	0.928
Share	0.112	0.112	0.112	0.112	0.113
Other nonmaterial services	24,182.980	24,473.500	24,738.090	24,955.000	25,137.860
Percent change	1.671	1.201	1.081	0.877	0.733
Share	0.012	0.033	0.013	0.013	0.013
Government, human investment	63,090.390	63,632.100	64,138.600	64,612.510	65,075.480
Percent change	1.073	0.859	0.796	0.739	0.716
Share	0.033	0.033	0.033	0.033	0.033
Government, health and human services	40,666.820	41,270.010	41,893.140	42,521.140	43,158.540
Percent change	1.526	1.483	1.510	1.499	1.499
Share	0.021	0.021	0.021	0.021	0.022
Government, administration and military	37,397.020	37,579.690	37,793.270	37,993.380	38,199.630
Percent change	0.918	0.488	0.568	0.529	0.543
Share	0.019	0.019	0.019	0.019	0.019
					

Table 8
Baseline Simulation for Polish Imports, Total

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Total imports	449,774.800	408,633.800	408,795.300	418,776.300	421,778.900
Percent change		-9.147	0.039	2.442	0.717
Import/GNP ratio	0.216	0.211	0.211	0.217	0.219
Share	1.000	1.000	1.000	1.000	1.000
Energy	59,388.190	57,526.920	60,437.530	62,417.220	63,668.880
Share	0.132	0.141	0.148	0.149	0.151
Metals	45,052.930	44,334.080	43,968.520	44,546.110	44,759.780
Share	0.100	0.108	0.108	0.106	0.106
Machinery	145,153.400	134,883.100	139,254.400	143,021.600	146,326.300
Share	0.323	0.330	0.341	0.342	0.347
Chemicals	53,937.790	53,505.140	48,994.860	50,807.310	49,149.500
Share	0.120	0.131	0.120	0.121	0.117
Mineral products	5,795.922	6,490.547	6,895.496	7,239.078	7,382.105
Share	0.013	0.016	0.017	0.017	0.018
Wood and paper products	9,394.620	8,602.293	8,481.641	8,624.785	8,669.781
Share	0.021	0.021	0.021	0.021	0.021
Light industry	18,969.240	20,561.660	20,153.840	20,408.660	20,178.850
Share	0.042	0.050	0.049	0.049	0.048
Processed foods	59,253.570	37,290.260	34,233.210	35,374.790	35,177.740
Share	0.132	0.091	0.084	0.084	0.083
Other industry	4,337.590	6,068.848	6,410.453	6,664.465	6,682.715
Share	0.010	0.015	0.016	0.016	0.016
Agricultural products	48,015.220	38,781.180	39,338.220	38,980.830	39,073.490
Share	0.107	0.095	0.096	0.093	0.093
Forest products	353.500	516.577	565.697	633.851	653.262
Share	0.001	0.001	0.001	0.002	0.002
Other products and services	123.408	73.828	62.050	58.241	57.118
Share	0.000	0.000	0.000	0.000	0.000

Table 8 (continued)

Million 1977 domestic zlotys

	1986	1987	1988	1989	1990
Total imports	432,624.400	441,314.800	451,006.300	460,328.900	470,044.800
Percent change	2.571	2.009	2.196	2.067	2.111
Import/GNP ratio	0.223	0.226	0.229	0.232	0.235
Share	1.000	1.000	1.000	1.000	1.000
Energy	65,534.680	67,542.310	69,862.000	72,556.810	75,698.500
Share	0.151	0.153	0.155	0.158	0.161
Metals	45,294.710	45,604.910	45,806.340	45,856.240	45,773.710
Share	0.105	0.103	0.102	0.100	0.097
Machinery	150,826.800	155,053.400	159,061.500	162,866.100	166,476.700
Share	0.349	0.351	0.353	0.354	0.354
Chemicals	50,872.450	51,180.130	52,367.520	53,193.720	54,253.190
Share	0.118	0.116	0.116	0.116	0.115
Mineral products	7,542.238	7,631.961	7,696.508	7,737.996	7,767.031
Share	0.017	0.017	0.017	0.017	0.017
Wood and paper products	8,821.121	8,924.004	9,021.060	9,104.340	9,183.300
Share	0.020	0.020	0.020	0.020	0.020
Light industry	20,345.620	20,450.380	20,623.960	20,800.140	20,991.240
Share	0.047	0.046	0.046	0.045	0.045
Processed foods	35,744.330	36,072.350	36,507.060	36,904.750	37,320.610
Share	0.083	0.082	0.081	0.080	0.079
Other industry	6,736.980	6,737.641	6,740.289	6,736.465	6,733.137
Share	0.016	0.015	0.015	0.015	0.014
Agricultural products	40,180.450	41,392.250	42,596.520	43,853.880	45,134.950
Share	0.093	0.094	0.094	0.095	0.096
Forest products	666.543	664.108	658.580	649.316	638.936
Share	0.002	0.002	0.001	0.001	0.001
Other products and services	59.004	61.918	65.501	69.548	74.004
Share	0.000	0.000	0.000	0.000	0.000
[REDACTED]					

Table 9
Baseline Simulation for Polish Hard Currency Imports

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Total hard currency imports	182,907.100	167,801.300	165,718.300	173,263.400	173,945.200
Percent change		-8.259	-1.241	4.553	0.393
Import/GNP ratio	0.088	0.086	0.085	0.090	0.090
Share	1.000	1.000	1.000	1.000	1.000
Energy	3,756.869	7,197.977	9,678.240	10,809.390	11,204.490
Share	0.021	0.043	0.058	0.062	0.064
Metals	10,866.290	10,823.310	11,199.120	11,634.530	12,030.410
Share	0.059	0.065	0.068	0.067	0.069
Machinery	38,205.630	37,436.040	39,947.060	42,009.000	43,692.480
Share	0.209	0.223	0.241	0.242	0.251
Chemicals	25,874.830	30,386.780	26,422.490	29,261.630	27,639.050
Share	0.141	0.181	0.159	0.169	0.159
Mineral products	2,672.552	2,618.724	2,725.794	2,884.714	2,973.376
Share	0.015	0.016	0.016	0.017	0.017
Wood and paper products	210.210	3,585.945	2,936.222	3,050.312	3,062.786
Share	0.001	0.021	0.018	0.018	0.018
Light industry	9,290.150	11,430.660	11,076.900	11,249.970	11,085.730
Share	0.051	0.068	0.067	0.065	0.064
Processed foods	45,925.980	27,502.850	25,294.250	26,155.890	26,004.050
Share	0.251	0.164	0.153	0.151	0.149
Other industry	2,688.868	3,673.498	3,978.199	4,205.082	4,252.348
Share	0.015	0.022	0.024	0.024	0.024
Agricultural products	43,209.520	32,831.500	32,103.550	31,591.500	31,567.340
Share	0.236	0.196	0.194	0.182	0.181
Forest products	171.990	284.104	326.715	381.548	402.987
Share	0.001	0.002	0.002	0.002	0.002
Other products and services	34.528	30.228	30.020	30.182	30.479
Share	0.000	0.000	0.000	0.000	0.000

Table 9 (continued)*Million 1977 domestic zlotys*

	1986	1987	1988	1989	1990
Total hard currency imports	180,125.800	183,662.200	187,949.100	191,334.900	194,709.100
Percent change	3.553	1.963	2.334	1.801	1.763
Import/GNP ratio	0.093	0.094	0.095	0.096	0.097
Share	1.000	1.000	1.000	1.000	1.000
Energy	11,327.430	11,280.610	11,172.310	11,032.840	10,876.570
Share	0.063.	0.061	0.059	0.058	0.056
Metals	12,442.890	12,711.320	12,835.540	12,808.830	12,634.960
Share	0.069	0.069	0.068	0.067	0.065
Machinery	45,505.560	47,037.590	48,330.990	49,414.180	50,313.130
Share	0.253	0.256	0.257	0.258	0.258
Chemicals	29,540.020	29,527.540	30,553.150	31,052.950	31,824.820
Share	0.164	0.161	0.163	0.162	0.163
Mineral products	3,068.656	3,127.688	3,169.273	3,196.248	3,214.564
Share	0.017	0.017	0.017	0.017	0.017
Wood and paper products	3,111.186	3,143.035	3,171.303	3,194.588	3,215.865
Share	0.017	0.017	0.017	0.017	0.017
Light industry	11,198.740	11,269.480	11,389.170	11,509.090	11,639.020
Share	0.062	0.061	0.061	0.060	0.060
Processed foods	26,497.940	26,815.860	27,215.670	27,588.660	27,976.710
Share	0.147	0.146	0.145	0.144	0.144
Other industry	4,301.563	4,304.551	4,302.363	4,293.570	4,283.992
Share	0.024	0.023	0.023	0.022	0.022
Agricultural products	32,684.910	33,997.550	35,366.520	36,809.060	38,304.190
Share	0.181	0.185	0.188	0.192	0.197
Forest products	416.208	416.051	411.692	403.585	393.983
Share	0.002	0.002	0.002	0.002	0.002
Other products and services	30.959	31.258	31.454	31.552	31.569
Share	0.000	0.000	0.000	0.000	0.000
[REDACTED]					

Table 10
Baseline Simulation for Polish Soft Currency Imports

Million 1977 domestic zlotys

	1981	1982	1983	1984	1985
Total soft currency imports	266,867.800	240,832.600	243,077.100	245,512.800	247,833.800
Percent change		-9.756	0.932	1.002	0.945
Import/GNP ratio	0.128	0.124	0.125	0.127	0.129
Share	1.000	1.000	1.000	1.000	1.000
Energy	55,631.320	50,328.950	50,759.290	51,607.830	52,464.390
Share	0.208	0.209	0.209	0.210	0.212
Metals	34,186.640	33,510.770	32,769.400	32,911.580	32,729.380
Share	0.128	0.139	0.135	0.134	0.132
Machinery	106,947.800	97,447.100	99,307.300	101,012.600	102,633.900
Share	0.401	0.405	0.409	0.411	0.414
Chemicals	28,062.960	23,118.360	22,572.370	21,545.680	21,510.450
Share	0.105	0.096	0.093	0.088	0.087
Mineral products	3,123.370	3,871.824	4,169.703	4,354.367	4,408.730
Share	0.012	0.016	0.017	0.018	0.018
Wood and paper products	9,184.410	5,016.352	5,545.422	5,574.477	5,606.996
Share	0.034	0.021	0.023	0.023	0.023
Light industry	9,679.090	9,131.000	9,076.940	9,158.690	9,093.110
Share	0.036	0.038	0.037	0.037	0.037
Processed foods	13,327.590	9,787.410	8,938.969	9,218.910	9,173.690
Share	0.050	0.041	0.037	0.038	0.037
Other industry	1,648.724	2,395.352	2,432.257	2,459.386	2,430.368
Share	0.006	0.010	0.010	0.010	0.010
Agricultural products	4,805.699	5,949.688	7,234.668	7,389.324	7,506.148
Share	0.018	0.025	0.030	0.030	0.030
Forest products	181.510	232.473	238.982	252.303	250.275
Share	0.001	0.001	0.001	0.001	0.001
Other products and services	88.880	43.599	32.030	28.059	26.639
Share	0.000	0.000	0.000	0.000	0.000

Table 10 (continued)

Million 1977 domestic zlotys

	1986	1987	1988	1989	1990
Total soft currency imports	252,498.600	257,652.600	263,057.100	268,994.000	275,335.700
Percent change	1.882	2.041	2.098	2.257	2.357
Import/GNP ratio	0.130	0.132	0.134	0.136	0.138
Share	1.000	1.000	1.000	1.000	1.000
Energy	54,207.260	56,261.730	58,689.740	61,524.020	64,821.950
Share	0.215	0.218	0.223	0.229	0.235
Metals	32,851.830	32,893.580	32,970.800	33,047.410	33,138.740
Share	0.130	0.128	0.125	0.123	0.120
Machinery	105,321.300	108,015.900	110,730.600	113,452.000	116,163.600
Share	0.417	0.419	0.421	0.422	0.422
Chemicals	21,332.420	21,652.590	21,814.360	22,140.780	22,428.370
Share	0.084	0.084	0.083	0.082	0.081
Mineral products	4,473.586	4,504.273	4,527.234	4,541.750	4,552.469
Share	0.018	0.017	0.017	0.017	0.017
Wood and paper products	5,709.938	5,780.973	5,849.758	5,909.750	5,967.438
Share	0.023	0.022	0.022	0.022	0.022
Light industry	9,146.880	9,180.390	9,234.790	9,291.050	9,352.220
Share	0.036	0.036	0.035	0.035	0.034
Processed foods	9,246.390	9,256.490	9,291.390	9,316.090	9,343.890
Share	0.037	0.036	0.035	0.035	0.034
Other industry	2,435.419	2,433.091	2,437.928	2,442.896	2,449.147
Share	0.010	0.009	0.009	0.009	0.009
Agricultural products	7,495.539	7,394.699	7,229.996	7,044.816	6,830.762
Share	0.030	0.029	0.027	0.026	0.025
Forest products	250.335	248.057	246.888	245.731	244.953
Share	0.001	0.001	0.001	0.001	0.001
Other products and services	28.045	30.660	34.047	37.996	42.435
Share	0.000	0.000	0.000	0.000	0.000
[REDACTED]					

Table 11
Baseline Simulation for Capital, Labor, and Energy
Requirements To Support Polish GNP Targets ^a

	1981	1982	1983	1984	1985
Capital stock	9,138.700	9,531.490	10,049.570	10,596.440	11,176.910
Percent change		4.298	5.435	5.442	5.478
GNP/capital ratio	227.722	203.595	193.083	182.176	172.446
Percent change		-10.595	-5.163	-5.649	-5.341
Capital/GNP elasticity		-0.637	-655.103	-10.579	-35.189
Labor	16,574.300	16,362.110	16,313.960	16,307.230	16,297.540
Percent change		-1.280	-0.294	-0.041	-0.059
GNP/labor ratio	125.561	118.601	118.941	118.378	118.264
Percent change		-5.543	0.287	-0.473	-0.096
Labor/GNP elasticity		0.190	35.464	0.080	0.381
Energy	2,342,998.000	2,098,165.000	2,032,251.000	1,985,959.000	1,943,681.000
Percent change		-10.450	-3.142	-2.278	-2.129
GNP/energy ratio	0.888	0.925	0.955	0.972	0.992
Percent change		4.128	3.235	1.805	2.016
Energy/GNP elasticity		1.548	378.634	4.428	13.675
Coal	1,796,998.000	1,605,921.000	1,538,146.000	1,480,746.000	1,423,403.000
Percent change		-10.633	-4.220	-3.732	-3.873
Share	0.767	0.765	0.757	0.746	0.732
Oil	340,000.000	293,665.500	279,595.500	271,168.300	264,731.800
Percent change		-13.628	-4.791	-3.014	-2.374
Share	0.145	0.140	0.138	0.137	0.136
Gas	188,000.000	187,391.900	203,751.100	223,366.600	244,932.200
Percent change		-0.323	8.730	9.627	9.655
Share	0.080	0.089	0.100	0.112	0.126
Hydro/nuclear	18,000.000	11,188.240	10,759.860	10,679.720	10,615.940
Percent change		-37.843	-3.829	-0.745	-0.597
Share	0.008	0.005	0.005	0.005	0.005

^a Capital stock in billion zlotys of 1 January 1977. Labor in thousand workers. Energy in barrels per day oil equivalent. GNP in million 1977 domestic zlotys.

Table 11 (continued)

	1986	1987	1988	1989	1990
Capital stock	11,804.570	12,469.520	13,170.770	13,912.070	14,694.590
Percent change	5.616	5.633	5.624	5.628	5.625
GNP/capital ratio	164.348	156.790	149.526	142.629	136.037
Percent change	-4.696	-4.599	-4.633	-4.613	-4.622
Capital/GNP elasticity	8.561	7.267	7.701	7.447	7.571
Labor	16,320.710	16,348.570	16,376.320	16,404.150	16,431.820
Percent change	0.142	0.171	0.170	0.170	0.169
GNP/labor ratio	118.871	119.588	120.258	120.961	121.654
Percent change	0.513	0.603	0.560	0.585	0.573
Labor/GNP elasticity	0.217	0.220	0.232	0.225	0.227
Energy	1,931,808.000	1,927,984.000	1,930,147.000	1,938,385.000	1,951,421.000
Percent change	-0.611	-0.198	0.112	0.427	0.672
GNP/energy ratio	1.004	1.014	1.020	1.024	1.024
Percent change	1.275	0.975	0.617	0.328	0.070
Energy/GNP elasticity	-0.931	-0.255	0.154	0.565	0.905
Coal	1,386,499.000	1,353,811.000	1,324,247.000	1,297,802.000	1,273,609.000
Percent change	-2.593	-2.358	-2.184	-1.997	-1.864
Share	0.718	0.702	0.686	0.670	0.653
Oil	263,517.800	263,861.800	264,984.100	266,740.700	268,786.100
Percent change	-0.459	0.130	0.425	0.663	0.767
Share	0.136	0.137	0.137	0.138	0.138
Gas	271,149.500	299,637.900	330,210.900	363,101.300	398,249.100
Percent change	10.704	10.507	10.203	9.960	9.680
Share	0.140	0.155	0.171	0.187	0.204
Hydro/nuclear	10,643.130	10,675.050	10,706.780	10,742.240	10,777.640
Percent change	0.256	0.300	0.297	0.331	0.330
Share	0.006	0.006	0.006	0.006	0.006

* Capital stock in billion zlotys of 1 January 1977. Labor in thousand workers. Energy in barrels per day oil equivalent. GNP in million 1977 domestic zlotys.